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FINAL REPORT
ON
"ADDED SCOPE"
TO
CONTRACT NAS8-34337
BETA EXPERIMENT

APRIL 30, 1983

PREPARED BY:

APPLIED RESEARCH, INC.
131 LONGWOOD DRIVE
P. O. BOX 194
HUNTSVILLE, ALABAMA 35804

Applied Research, Inc.

P. O. Box 194 • Huntsville, Alabama 35804 • (205) 533-6987

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1. INTRODUCTION

Applied Research, Inc. is pleased to submit this final report on an added scope to Contract NAS8-34337 with NASA/MSFC. This contract has centered on tasks which support the Beta Flight Test Experiment which uses an aircraft-borne laser Doppler velocimeter to measure the aerosol backscatter coefficient. Tasks reported on under this added scope of work are:

A. Using the Beta algorithms developed in previous studies the contractor will examine the 1982 Beta Flight Test Data for determining the Atmospheric Backscatter coefficient.

B. Install a signal processing/enhancement program from earlier studies and provided by the COR on a computer mutually selected by the contractor and the COR.

C. Perform a preliminary analysis to determine the signal processing methods which appear to be prime candidates for combining, to yield enhanced processing capabilities for low signal-to-noise ratios.

D. Demonstrate by simulation the combinations obtained in Task C using the program from Task B.

2. BETA FLIGHT TEST DATA ANALYSIS

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Applied Research, Inc. has calculated atmospheric backscatter (β) from data taken by NASA in the summer of 1982. See the Applied Research report to NASA entitled "Beta Experiment Flight Report, Contract No. NAS8-34337, August 1982" for a description of the various flights. This data was taken by a Laser Doppler Velocimeter (LDV) operating in a single particle detection mode. The single particle detection mode utilizes a focus position where the majority of backscatter detections is singular. A focus of 10 meters was determined to be sufficient to encounter single particles the majority of the time.

Applied Research's plan to generate atmospheric backscatter values for the various flights was to produce a computer code incorporating a previously developed algorithm which required the single particle count data (histograms) as input. The output of this computer code is the atmospheric backscatter coefficient calculated from single particle data and is called "single particle β ." NASA also requested that Applied Research process the volume data channel. Therefore, code was generated to also output a volume channel β value. A description of the final computer code will be discussed in the following sections and Appendix A contains a complete listing. In order to set up the computer code for automatic processing, several computational quantities had to be defined. These quantities were:

- 1) Establish correlation between signal value and channel number on the signal processor.
- 2) Establish the $\frac{S/N}{\sigma}$ value that corresponds to "zero Area", i.e., determine absolute scale for $\frac{S/N}{\sigma}$ vs. Area.

3) L_{eff} at 10 meters.

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4) Waist S/N return at 10 meters.

Applied Research had previously performed the LDV system calibration under Contract No. NAS8-34337. However, operation of the LDV at a focus of 10 meters required that additional data be taken to completely define the LDV system. The additional data was taken by W. Jones of NASA and consisted of the data required to calculate L_{eff} at 10 meters and the waist S/N at a 10 meter focus. Applied Research's "Final Report - Beta Experiment" has a description of L_{eff} and how it is calculated for an LDV system.

Signal Processor Channel Calibration data is required to establish the correlation between signal value and signal bin (channel) on the signal processor. This relationship was established by W. Jones of NASA and is shown in Figure 1. This curve was used for all single particle β predictions in this report.

In Applied Research Final Report - Beta Experiment, a plot showing the relative relationship between Signal/Noise/Cross-section ($\frac{S/N}{\sigma}$) and Area (Figure 2) was presented. Since plot has an arbitrary scale, it was necessary to establish an absolute scale for Signal/Noise/Cross-section vs. Area. This is the "single particle calibration" which was done using a sandpaper disk at a focus of 10 meters. The following section contains the theoretical argument for the single particle calibration.

- Single Particle Calibration

In terms of the backscattering elements σ_i of a rotating disk, the signal is $S = \sum \sigma_i g_i$ where g_i is the gain in the region of the i^{th} element. If elements of same value g_i are grouped together into regions denoted by area

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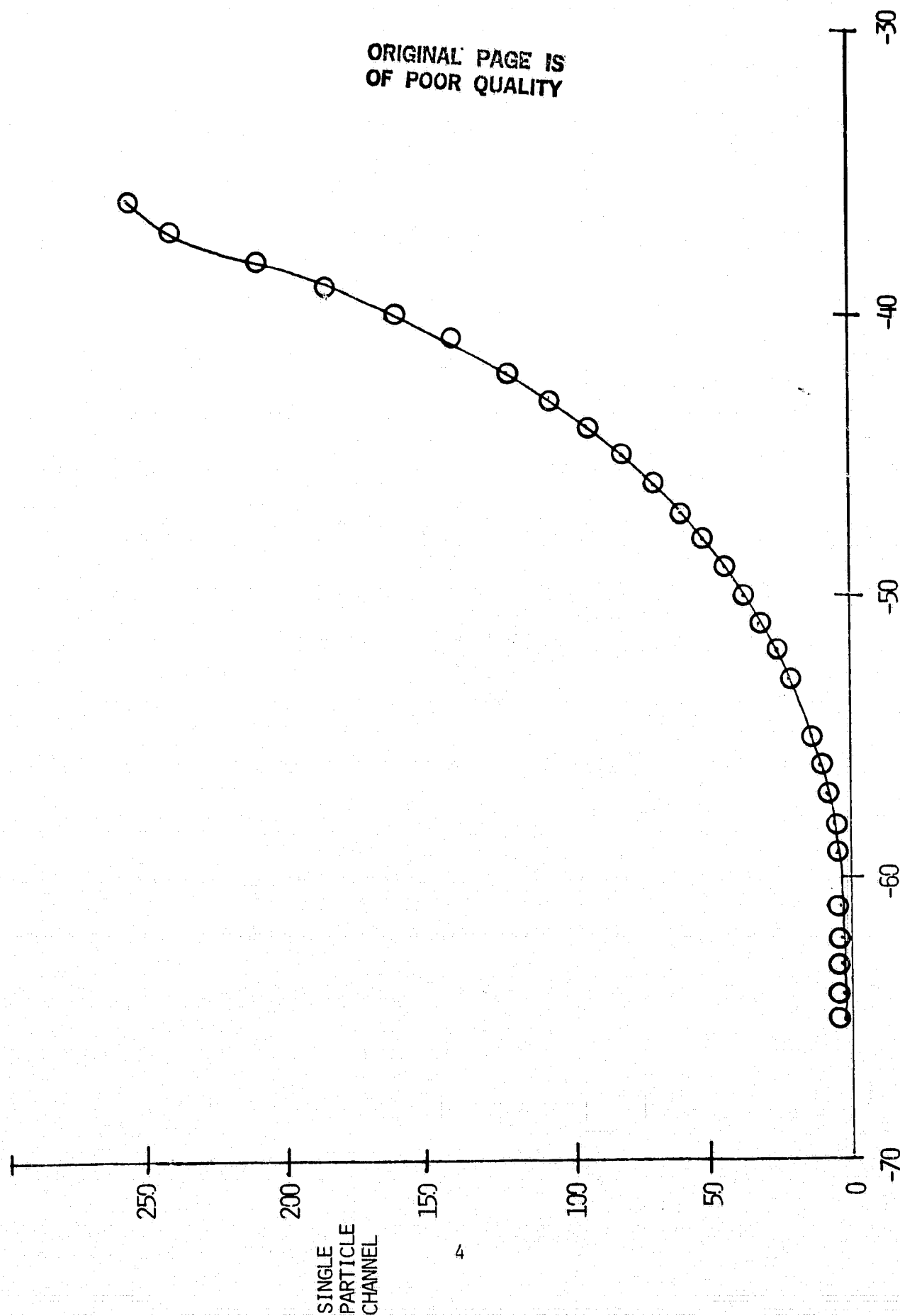


FIG. 1 SIGNAL PROCESSOR CHANNEL VS. SIGNAL LEVEL

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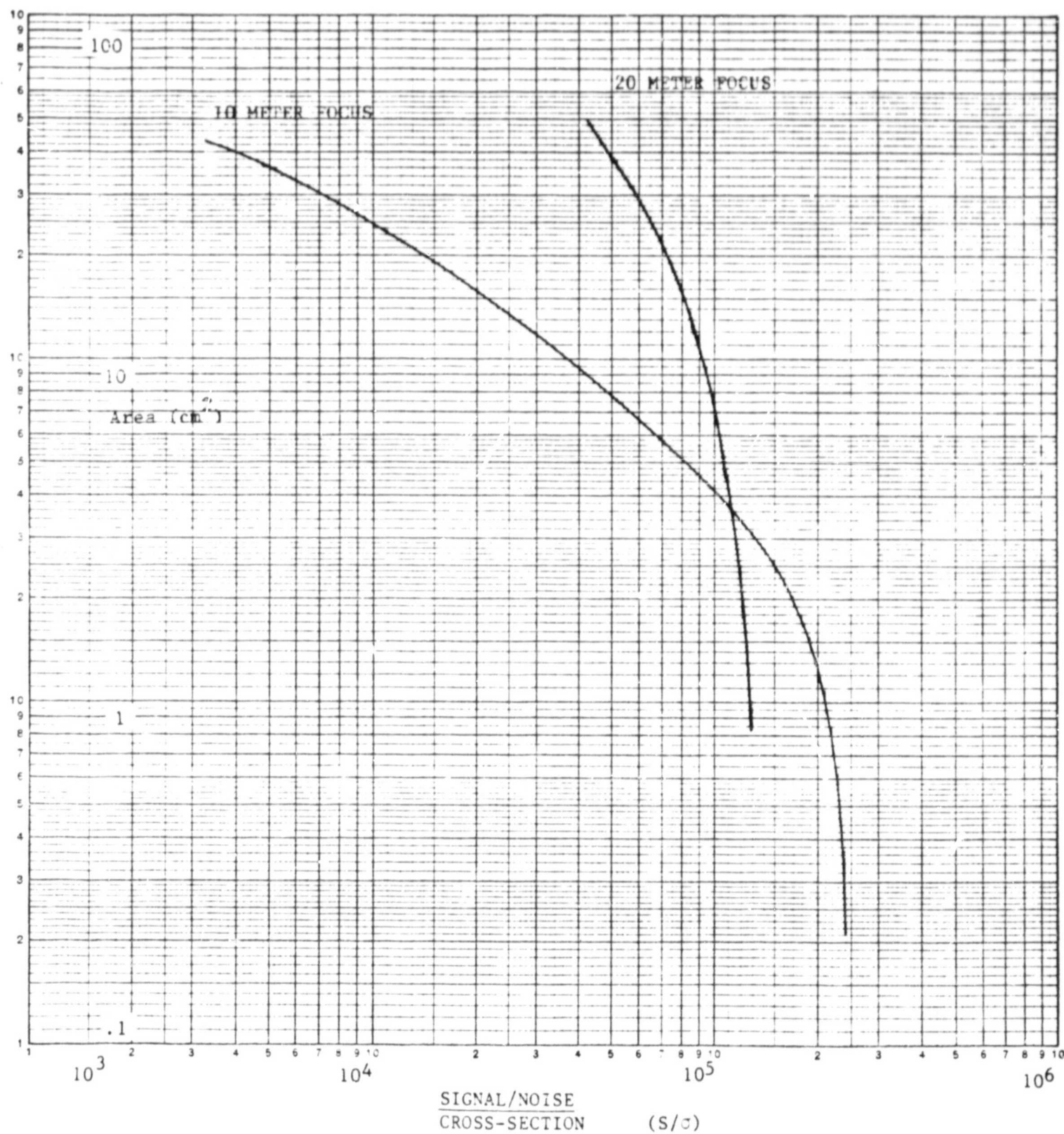


FIGURE 2. S/σ VERSUS AREA (RELATIVE SCALE)

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elements "a", then $S = \sum_a \left[\left(\sum_{i \in a} \sigma_i \right) g(a) \right]$. Now if $\sum \sigma_i = d\sigma$ is a differential, then $S = \sum_a \frac{d\sigma}{da} g da$. This can be rewritten as $S = \rho/g(a)da$, where $\rho = \frac{d\sigma}{da}$ is the bidirectional reflectance of the surface and is assumed independent of a. Since $g = S/\sigma$, Figure 2 can be used to obtain the calibration constant C where $g = C \cdot S/\sigma = Cg'$. C is some constant which will give the proper value to the equation $\frac{S'}{\rho} = \int Cg' da$, where S' is the signal return from a sandpaper disk at 10 meters, and g' is the relatively scaled S/N/ σ data. Figure 3 shows the calibration data which resulted from this exercise. This data allows a signal/noise/sigma to be associated with a particular area at a 10 meter focus.

By using the equation $\frac{S}{Q}|_0 = g(0)$ to tie-down the Area curve (Figure 3) at an Area of Q, a cross-section can be produced for each signal bin on the signal processor. This association of cross-section with signal bin was calculated for each single particle β prediction.

Algorithm Description

When all of the required information was completed, Applied Research proceeded to set up a computer code which would automate the data predictions. The computer prediction code has 3 major sections which are repeated over and over until the data is exhausted. The first section is a subroutine (GETDAT) to read the data off disk and translate the proper values to work arrays. The second section does the noise calculations for both the volume and single particle channels of the data. Both calculations are done by using the data to "look up" the noise values in a table. A linear interpolation is done in the table to obtain the final values. The third section is the subroutine (DATANAL) which is the single particle β inversion routine.

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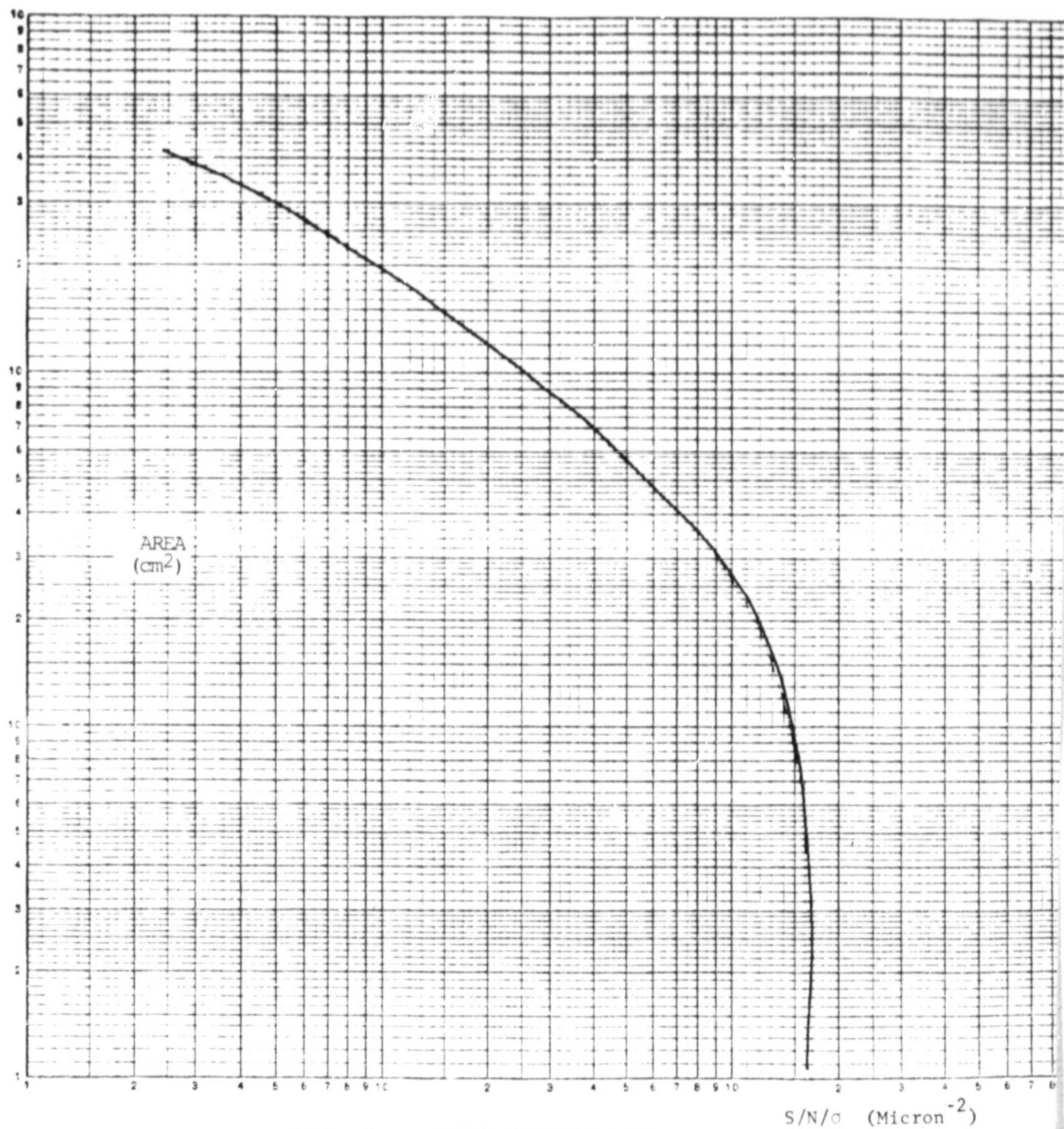


FIG. 3 S/N/σ VERSUS AREA
(Absolute Scale)

The BETA Data is packed into 768 byte records of the Signal V computer. Each record of data must be decoded into the 384 words which are identified in Table 1. The alternating noise samples were used to calculate a "noise factor" for each set of data processed by the algorithm. This was done by monitoring the integrated volume β word in the noise set of data and then calculating what noise (in dbm) corresponded to this value by using a "calibration table look up" with linear interpolation. The noise data blocks were further utilized by subtracting off the noise hits in each bin for the single particle BETA Data. Care was taken to compensate for bandwidth differences between single particle noise and volume channel noise data.

The Beta Inversion Algorithm requires approximately 10,000 particle hits to be accurate; therefore, the data had to be combined in most cases in order to obtain the 10,000 particle count minimum. When this was done, the time that corresponds to the data was also averaged over the data-taking interval. Therefore, the output of the algorithm was single particle β versus time. However, there is not a one-to-one correspondence between input data records and output data points due to the combining which occurs when the number of single particle hits is low.

A volume backscatter coefficient was also calculated for the same data as for the single particle β . This data requires integration since the LDV was focused at 10 meters where it is likely that most of the time single particles occupied the sensitive focal volume of the LDV. A volume β is normally defined as the backscatter return from a collection of particles measured at an instant. The volume Beta was calculated by using the following equation:

$$\beta = \frac{V_s/V_n}{S_d} \frac{\rho_o}{L_{eff}}$$

where V_s is the integrated volume single, V_n is the integrated volume noise,

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Table 1. DATA RECORD

0-	TIMH:	12	<u>CURRENT TIME</u>
	TIMM:	0	
	TIMS:	0	
	TIMF:	10°°	
4-	TIMH1:	12	<u>TIME AT START OF RECORD</u>
	TIMM1:	0	
	TIMS1:	0	
	TIMF1:	0	
8-	DATEM:	6	<u>CURRENT DATE</u>
	DATED:	1	
	DATEY:	32	
11-	STEPR1:	0	<u>STEPPER POSITIONS (NOT PRESENTLY USED)</u>
	STEPR2:	0	
	STEPR3:	0	
14-	VOLBH:	0	<u>VOLUME BETA INTEGRATORS</u>
	VOLBL:	0	
	VOJBN:	0	
19-	PARMS:	171356	<u>CONTROL REGISTER PARAMETERS</u>
	CLOCKP:	11.	<u>DIGITAL FILTER CLOCK PERIOD</u>
	FILTER:	2	<u>IF FILTER WIDTH</u>
20-	TIMEON:	3	<u>VIDEO TIME CONSTANT</u>
	VCOFRQ:	140.	<u>VCO FREQUENCY</u>
	DOFSET:	0 11.	<u>A/D FILTER BIAS</u>
23-	DISCRM:	0	<u>DISCRIMINATOR THRESHOLD</u>
	IFGAIN:	45.	<u>IF GAIN</u>
25-	FWDID:	0	<u>FORWARD/AFT IDENTIFIER</u>
	NDSETS:	1	<u># SCANS PER WRITE</u>
	INTSEC:	1000.	<u>MS PER INTEGRATION PERIOD</u>
	ADDASV:	0	<u>UP IF ADDAS LINK ON</u>
	ADDASI:	100.	<u># MS PER ADDAS OUTPUT</u>
30-	SCAN:	0	<u>UP IF SCANNER ENABLED</u>
	TASADD:	300	<u>TAS FROM ADDAS</u>
	TASKB:	300	<u>TAS FROM KEYBOARD</u>
	THETA:	500.	<u>ANGLE THETA IN .01-DEG UNITS</u>
34-	VCOOFS:	0	<u>VCO OFFSET IN 53-KHZ UNITS</u>

88 IDENT: BLHB 80.

IDENTIFICATION STRING

128

383 DATA

S_d^* is the signal to noise return of a sandpaper disk at 10 meters, ρ_d is the bidirectional reflectance of sandpaper and L_{eff} is the effective length of the LDV while focused at 10 meters. L_{eff} was calculated by using data generated by W. Jones at 10 meters which is shown in Figure 4. The corresponding L_{eff} is plotted in Figure 5, which shows how this data point fits in with other data points calculated by Applied Research.

The integrated signal, V_d , in the volume channel was calculated by subtracting off the average noise signal (V_n) for that time interval. The signal return from a sandpaper disk at 10 meters at the focal volume waist and the bidirectional reflectance of the sandpaper disk were supplied by W. Jones of NASA.

Prediction Results

A total of 23 flights were processed by Applied Research. Some flights had problems with the data which were caused by data transfer, but the large majority did not. The prediction algorithm had only two cases where it did not attempt to process the data: (1) If the airplane airspeed is less than 250 knots (such as at takeoff or landing) and (2) if the last signal bin contained more than 5,000 hits. Case No. 2 occurs whenever dense clouds are being flown through and since the algorithm predictions are inadequate here, the data is ignored. Figures 6 through 27-A show plots of single particle β and volume β as a function of time. Figures 28 through 49 show the average aerosol backscatter cross-section as a function of time. Figures 50 through 71 show the atmospheric aerosol number density as a function of time. The time on each plot is in minutes, calculated by multiplying the military hour by 60 and adding the minutes. Note that Flight 12 is missing completely

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because none of the data was processable by the single particle prediction algorithm. Other gaps in the data occur because of the two cases listed above. Note that there are some single particle β predictions on some flights which get very large. These instances correspond to cloud cases. In general those large values of β cannot be considered as accurate since the algorithm was not set up to handle high density large particles. The corresponding average cross-sections and densities would also be suspect. Figure 27-A shows the result of processing with only 1000 single particle hits. These results are not significantly different from those for 10,000 hits and indicate that shorter flight intervals per output beta point may be possible. Further analysis of this question is required.

The single particle and volume backscatter coefficients differ by a constant offset, the origin of which is not presently understood. This error may be found in the calibration techniques or processor assumptions. An evaluation of the uncertainties in the backscatter coefficient determinations would illuminate this problem.

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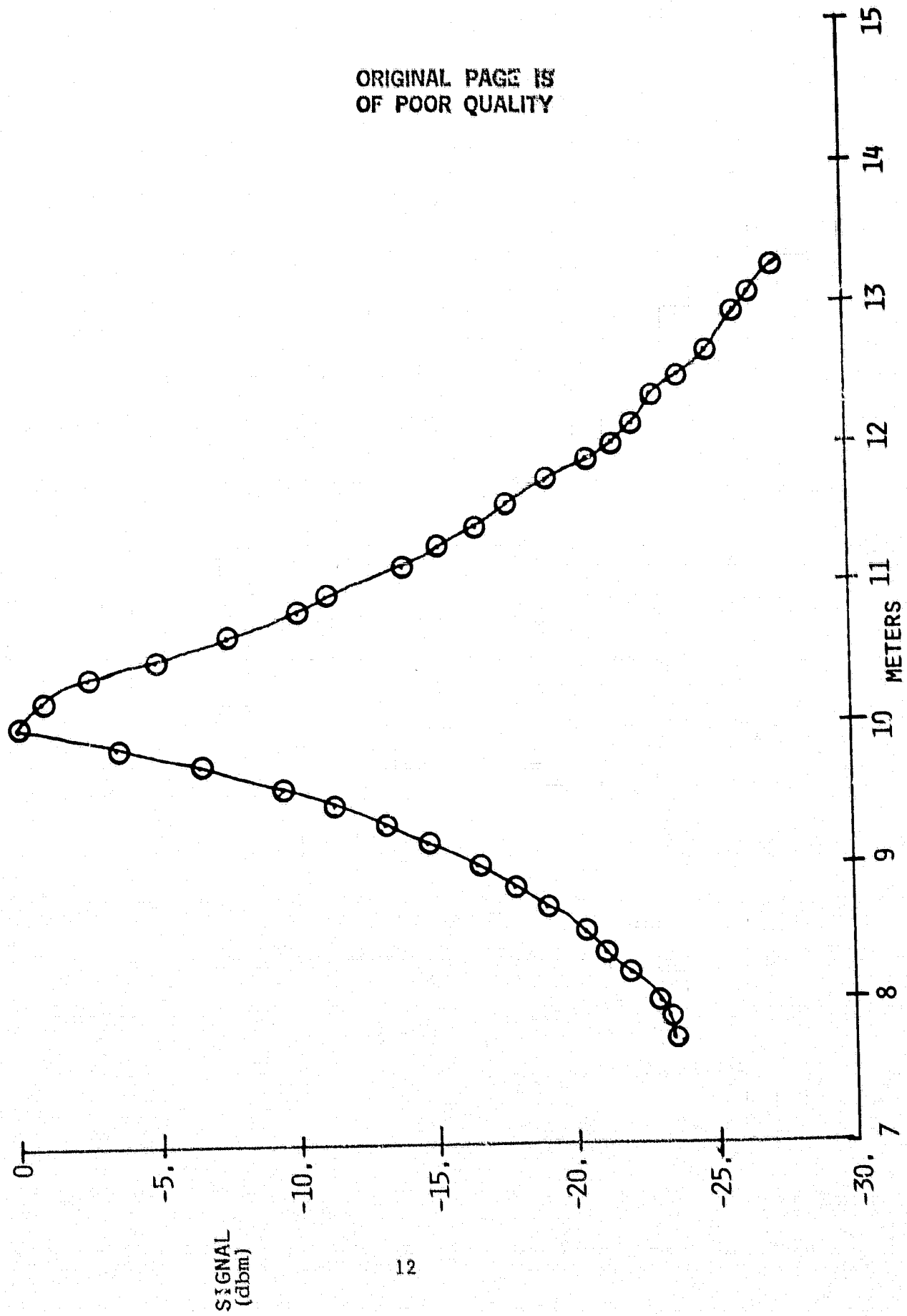


FIG. 4 LONGITUDINAL PROFILE AT 10 METER FOCUS

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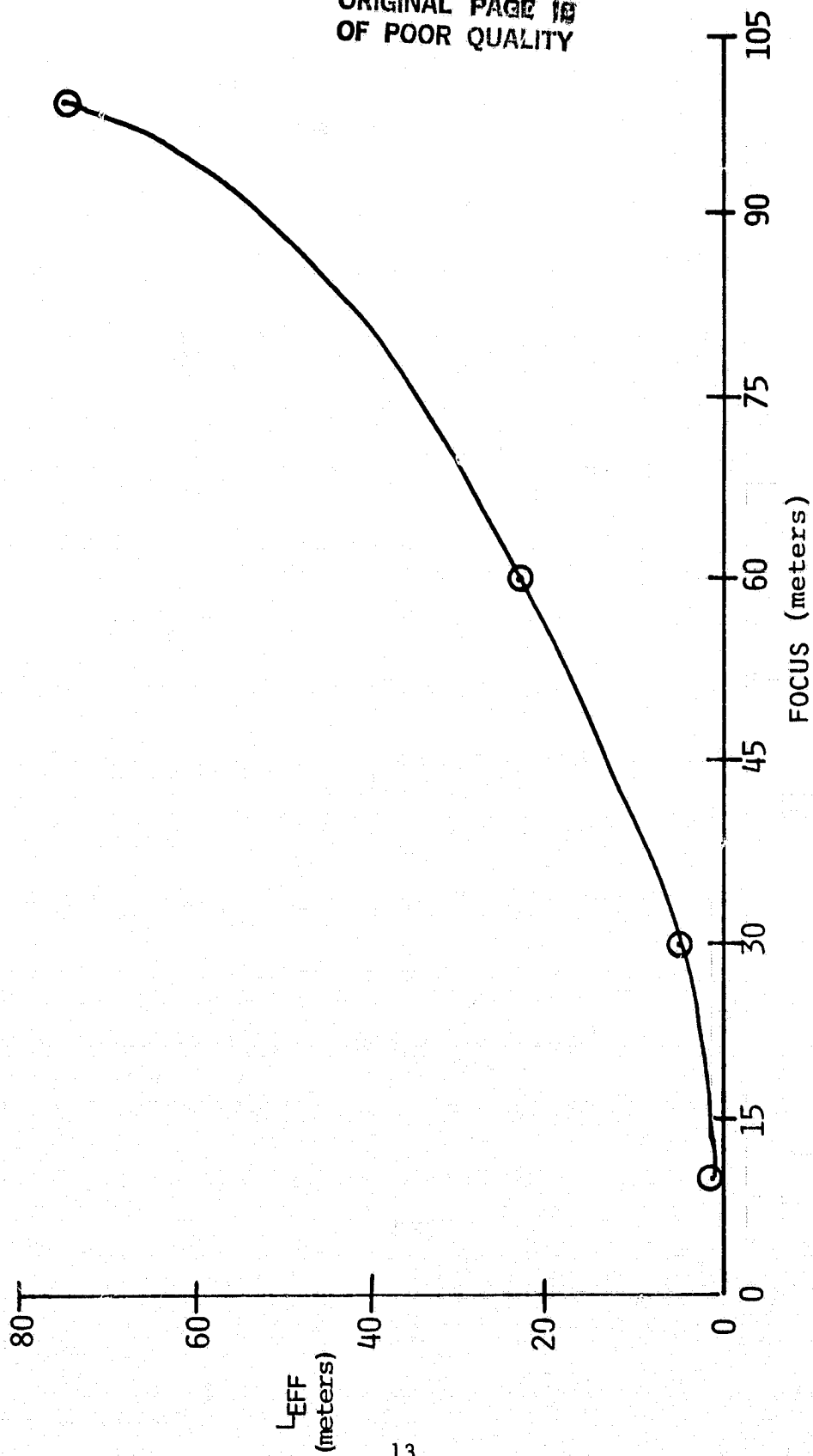


FIG. 5 L_{EFF} vs. FOCUS

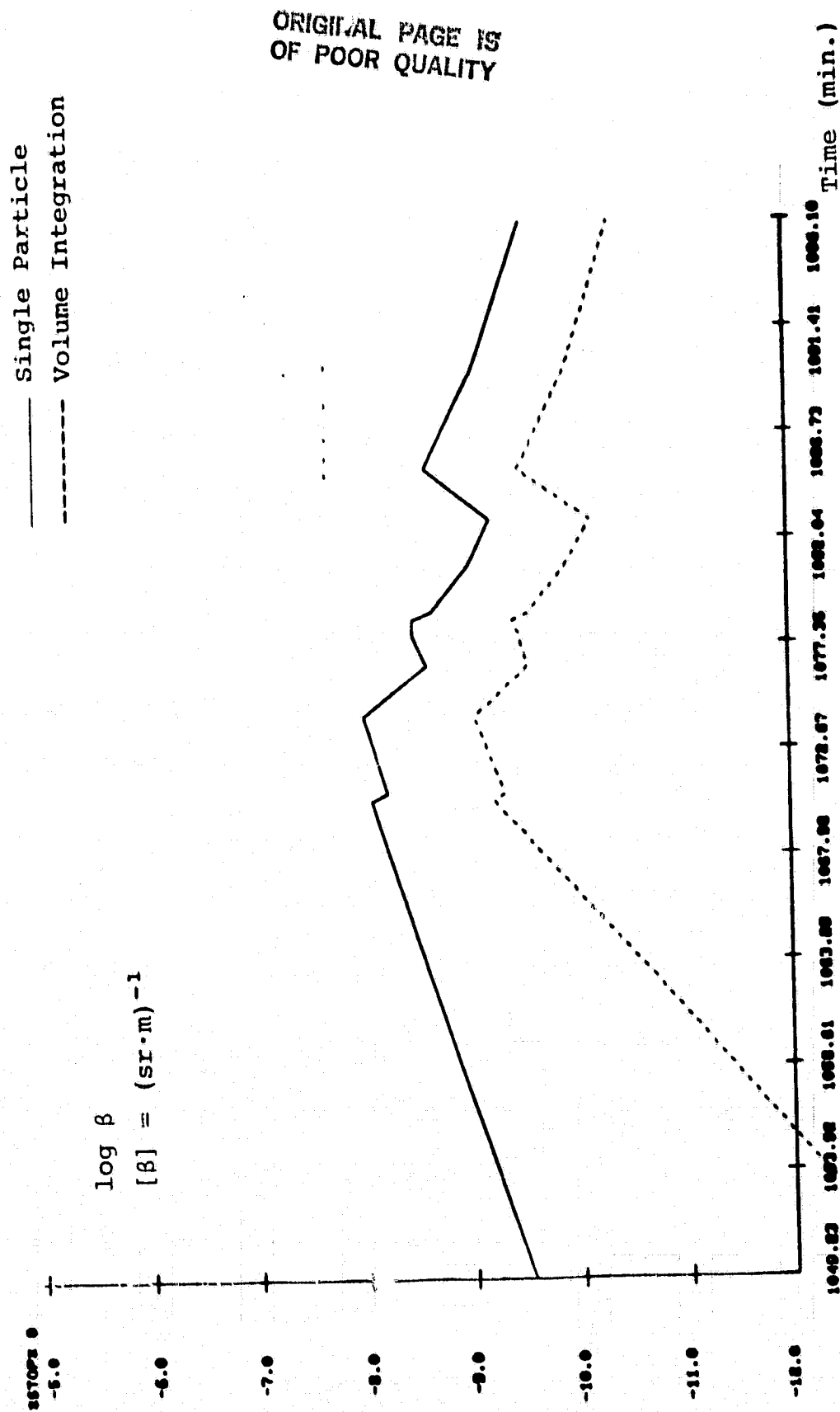


Fig. 6 Backscatter Coefficient β

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100000 10 2

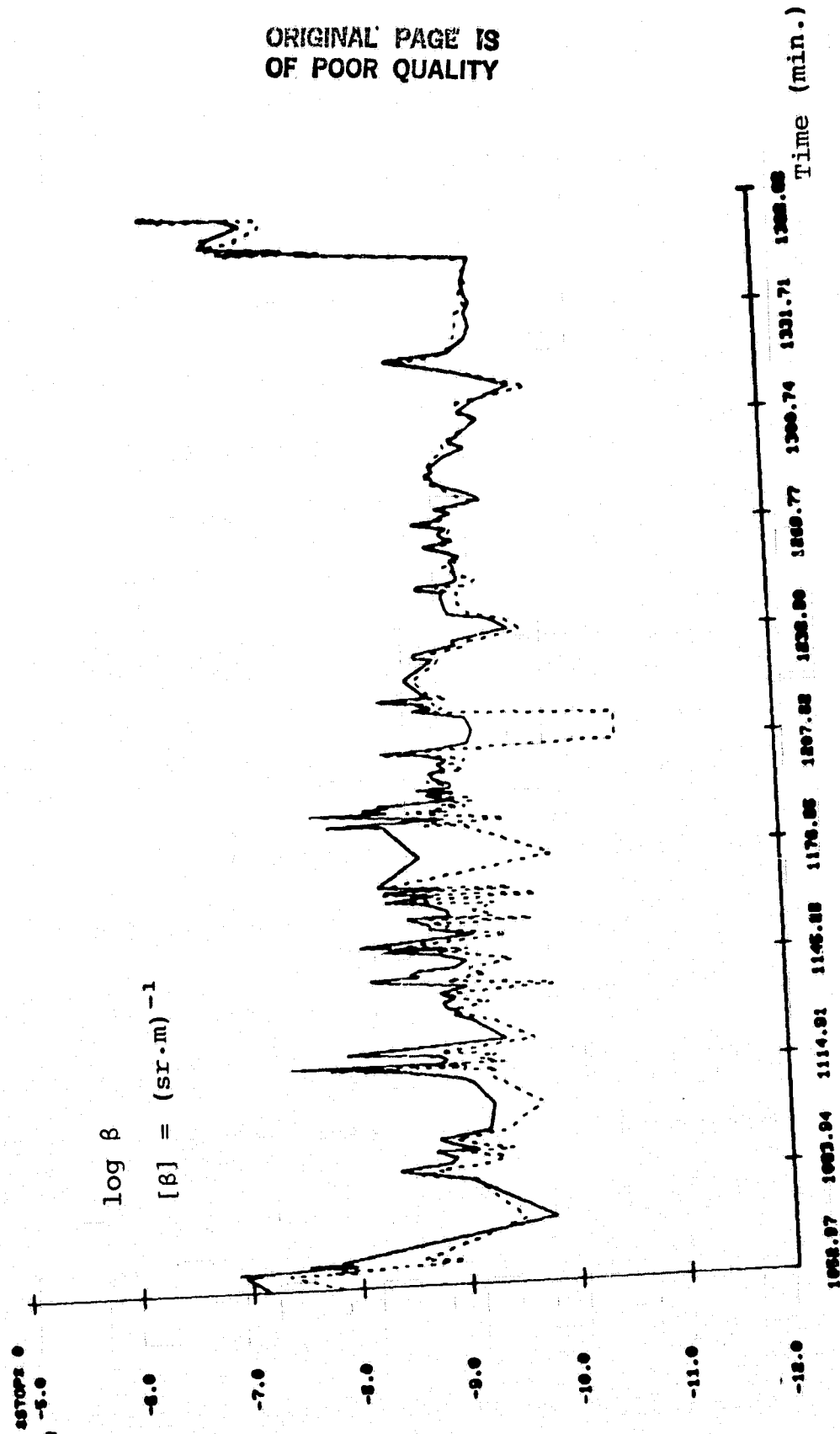


Fig. 7 Backscatter Coefficient β

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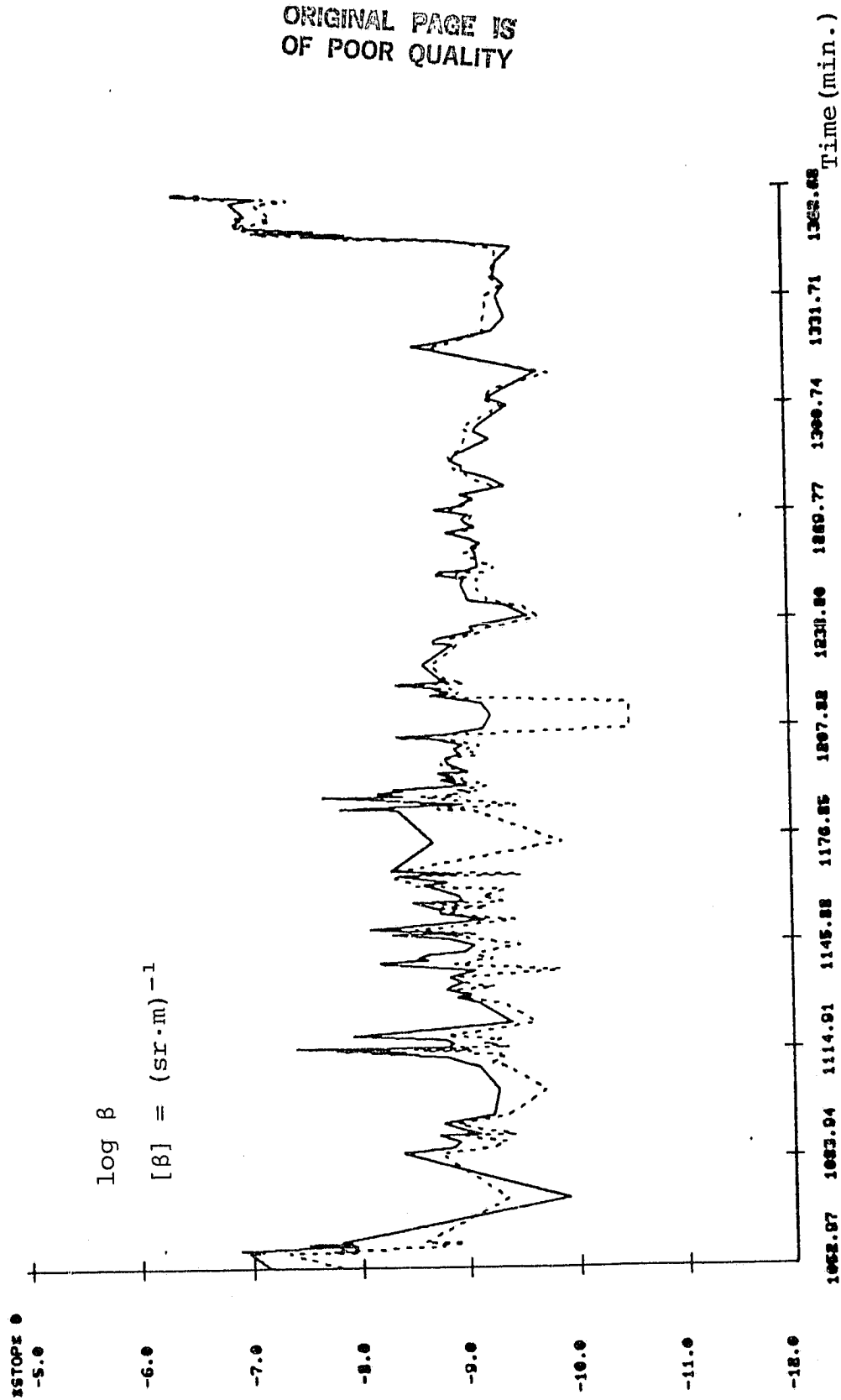


Fig. 8 Backscatter Coefficient β

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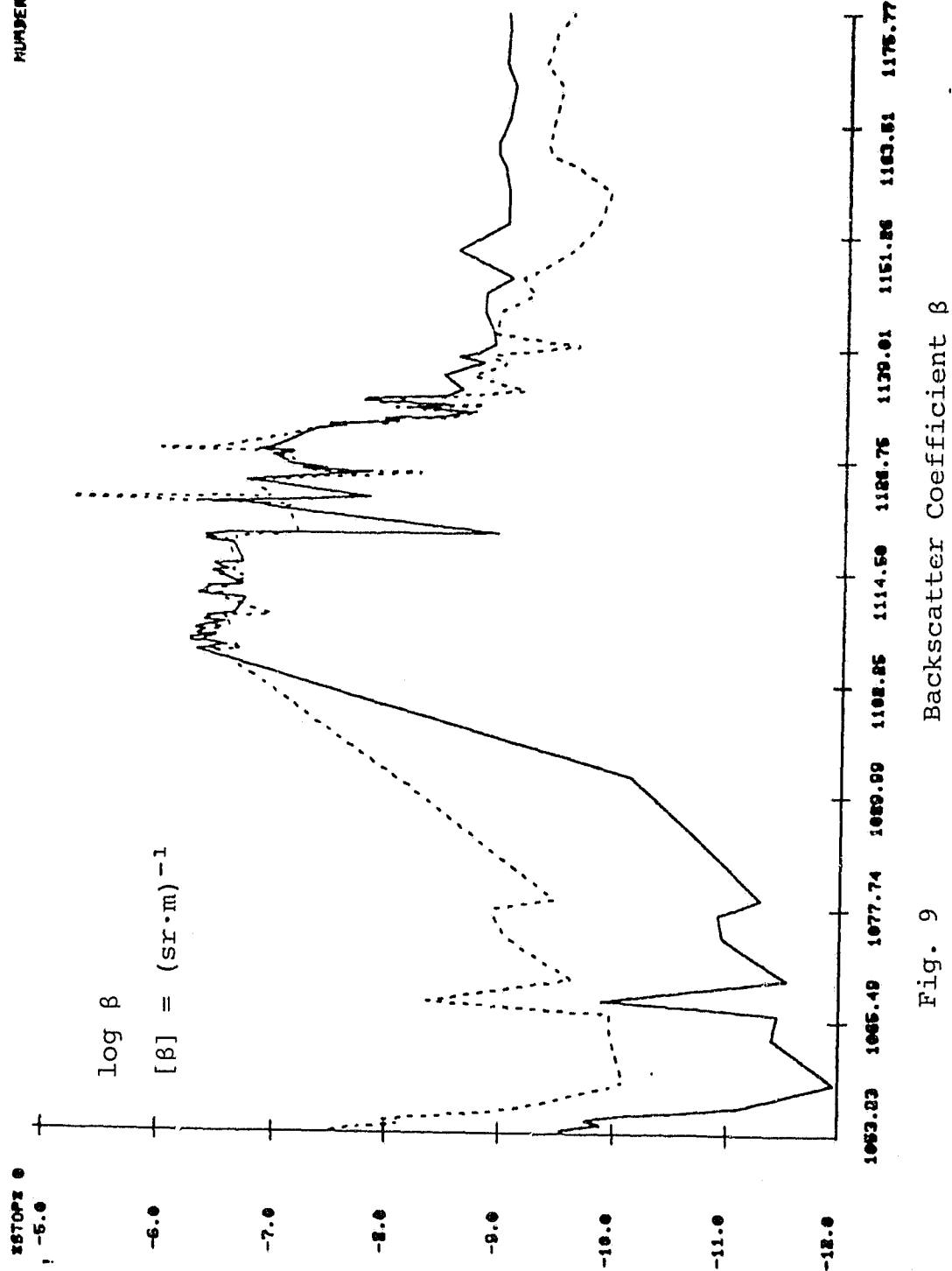


Fig. 9 Backscatter Coefficient β

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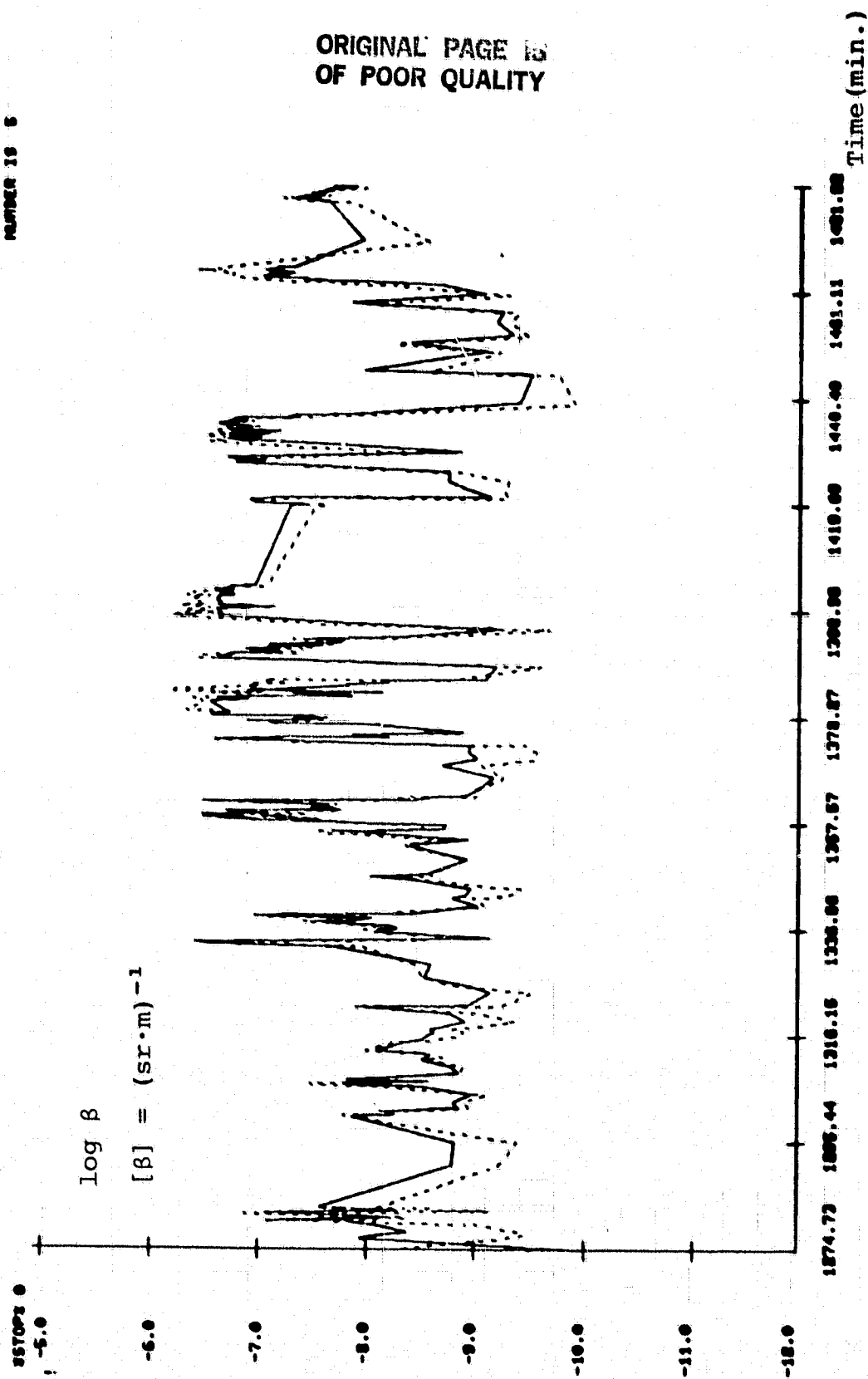


Fig. 10 Backscatter Coefficient β

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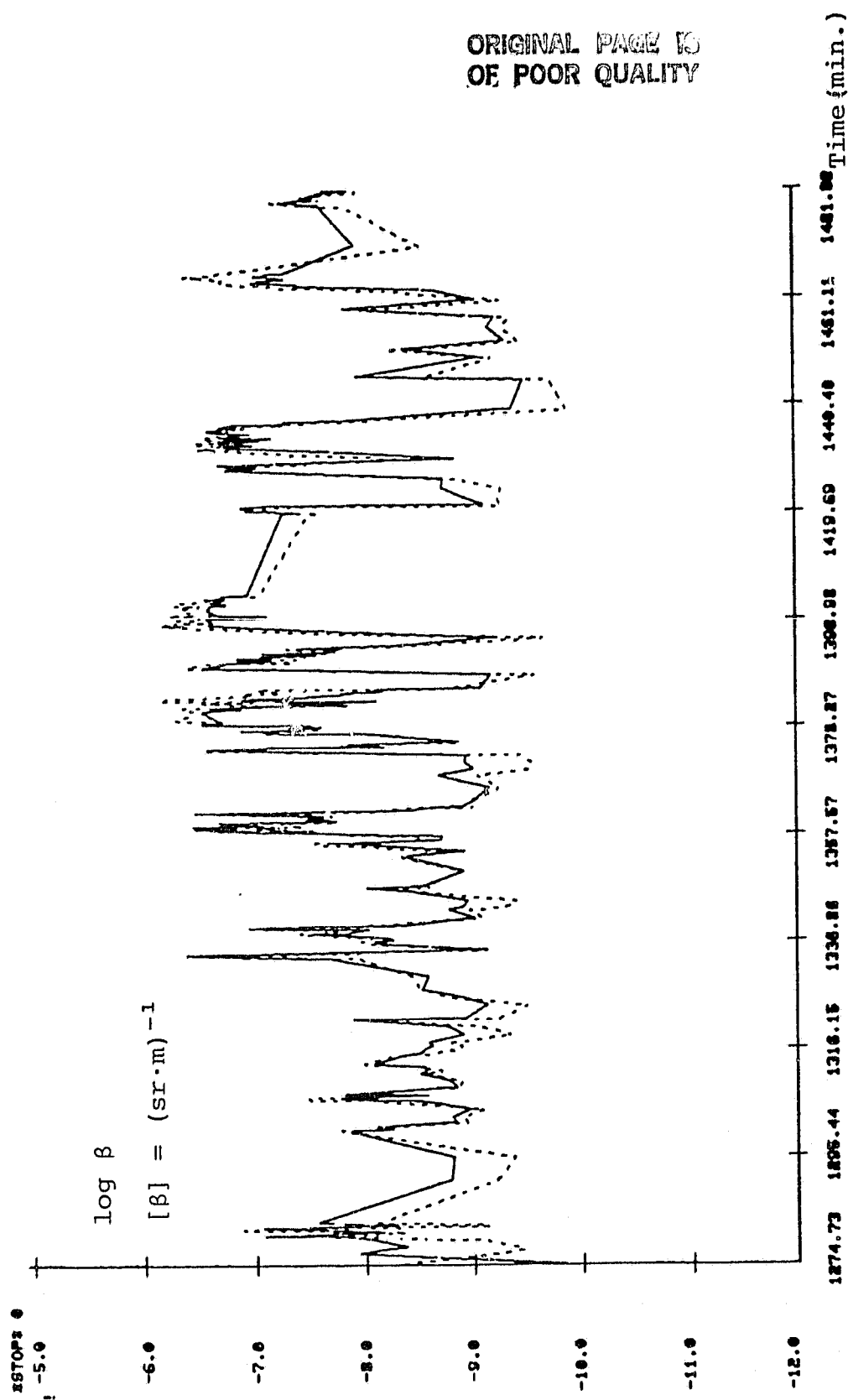


Fig. 11 Backscatter Coefficient β

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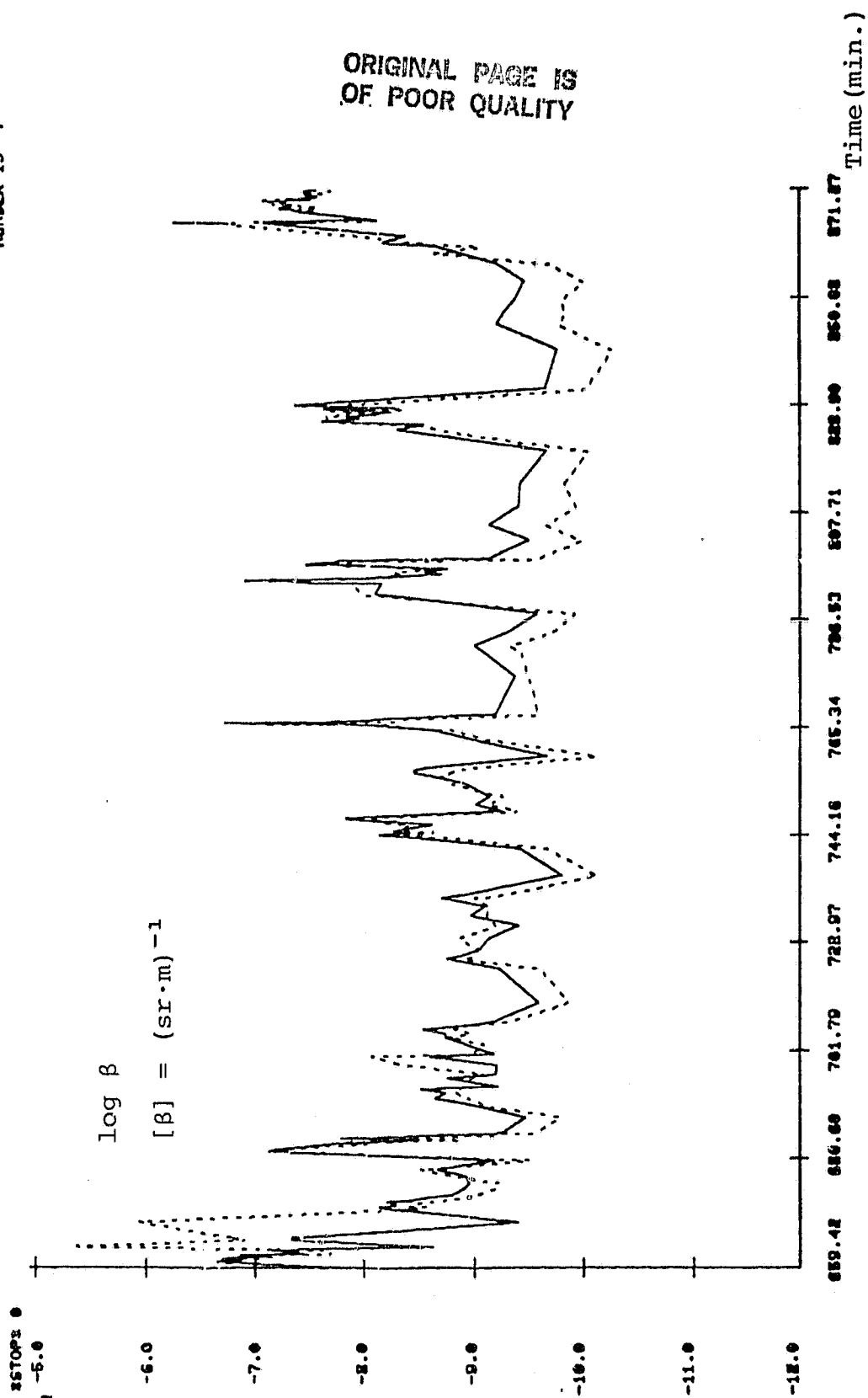


Fig. 12 Backscatter Coefficient β

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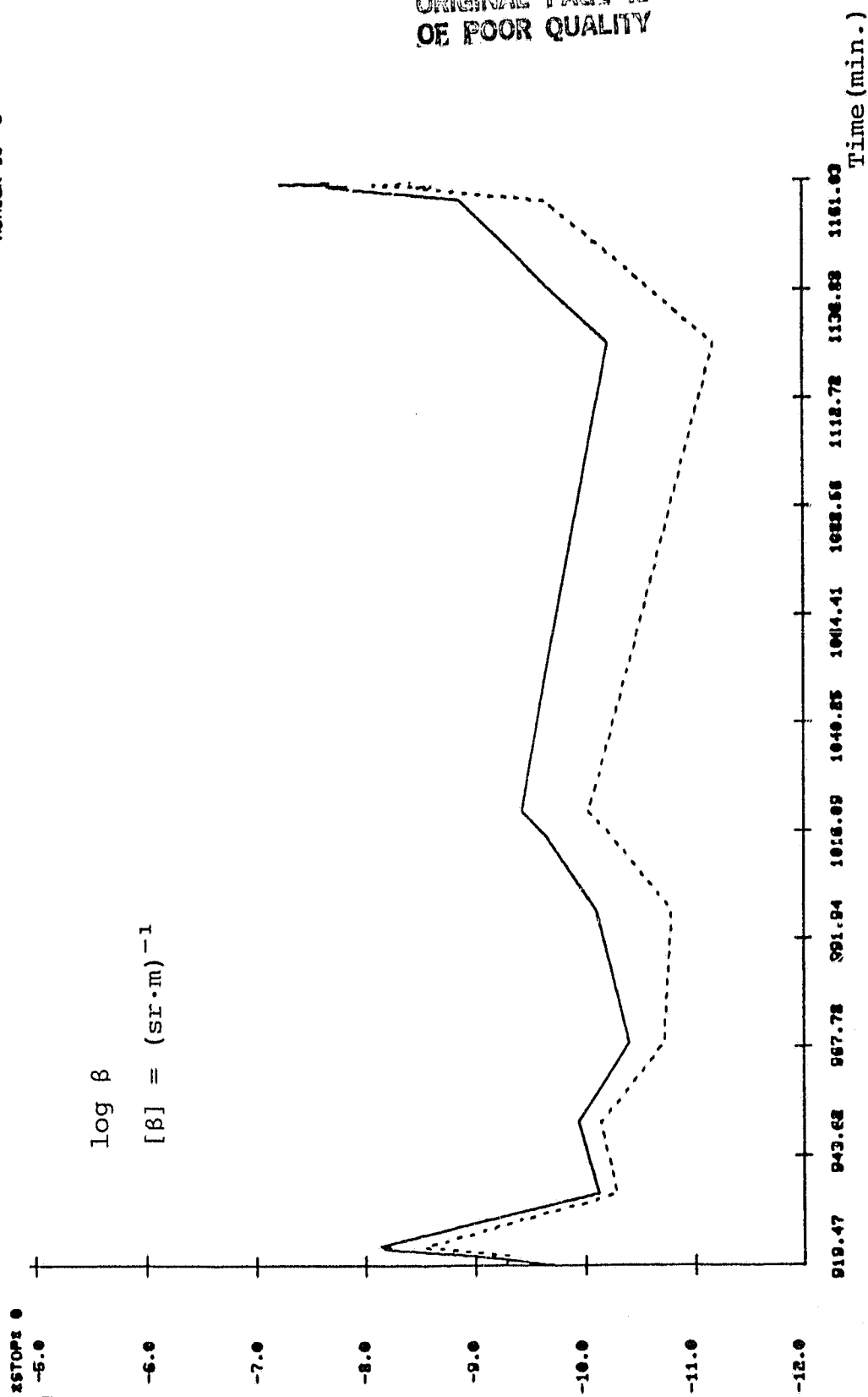


Fig. 13 Backscatter Coefficient β

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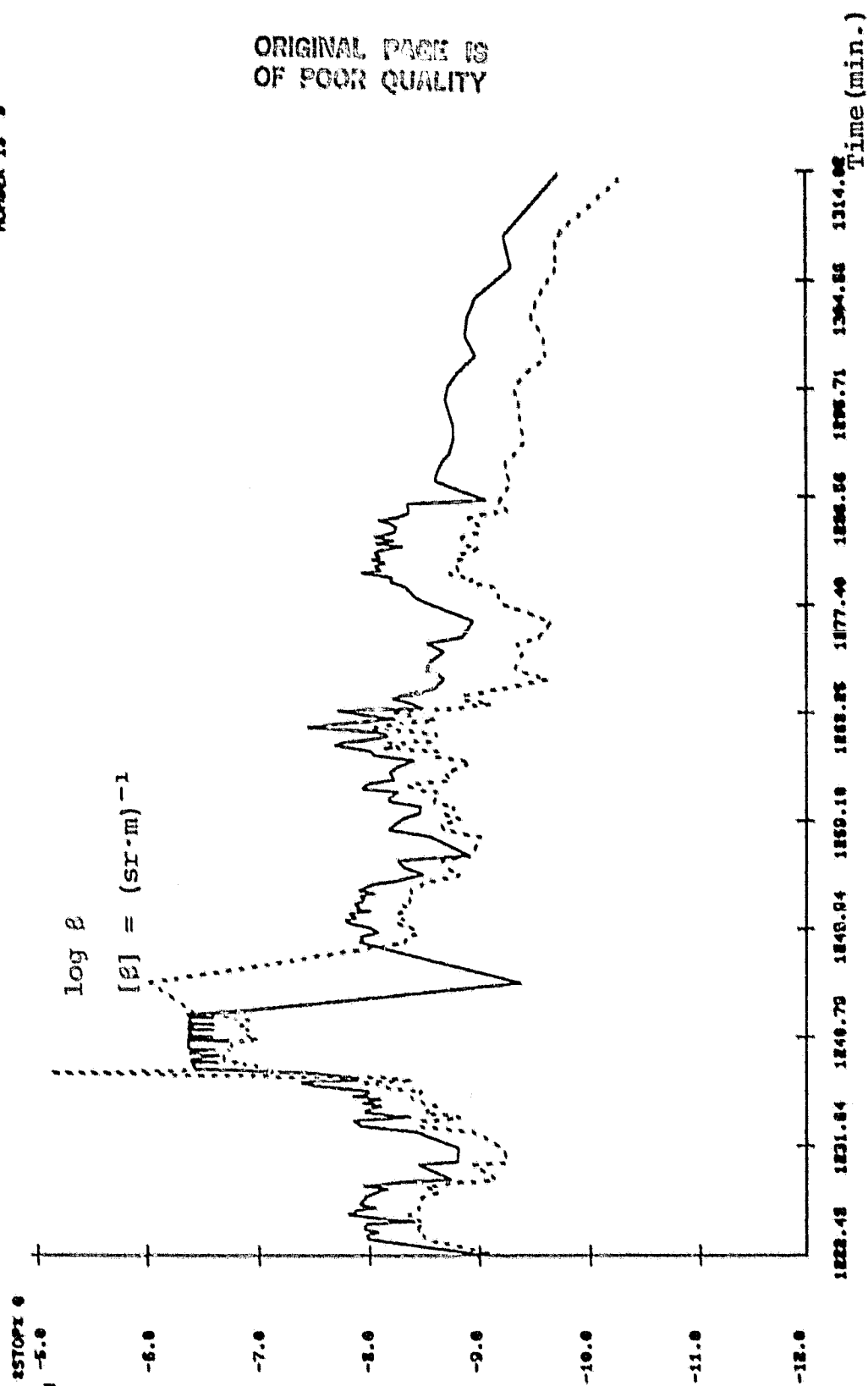
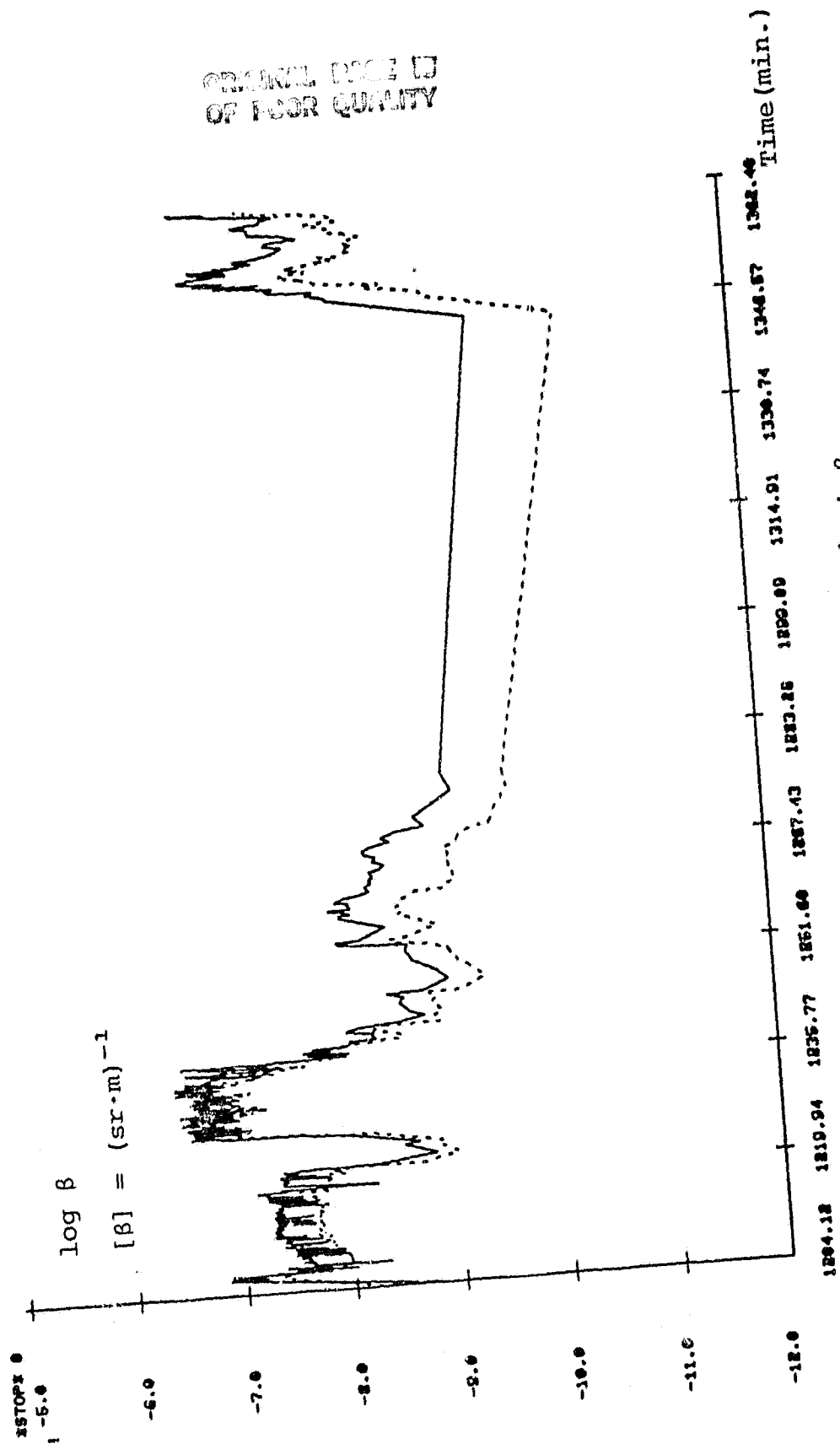


Fig. 14 Backscatter Coefficient β

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Backscatter Coefficient B

Fig. 15

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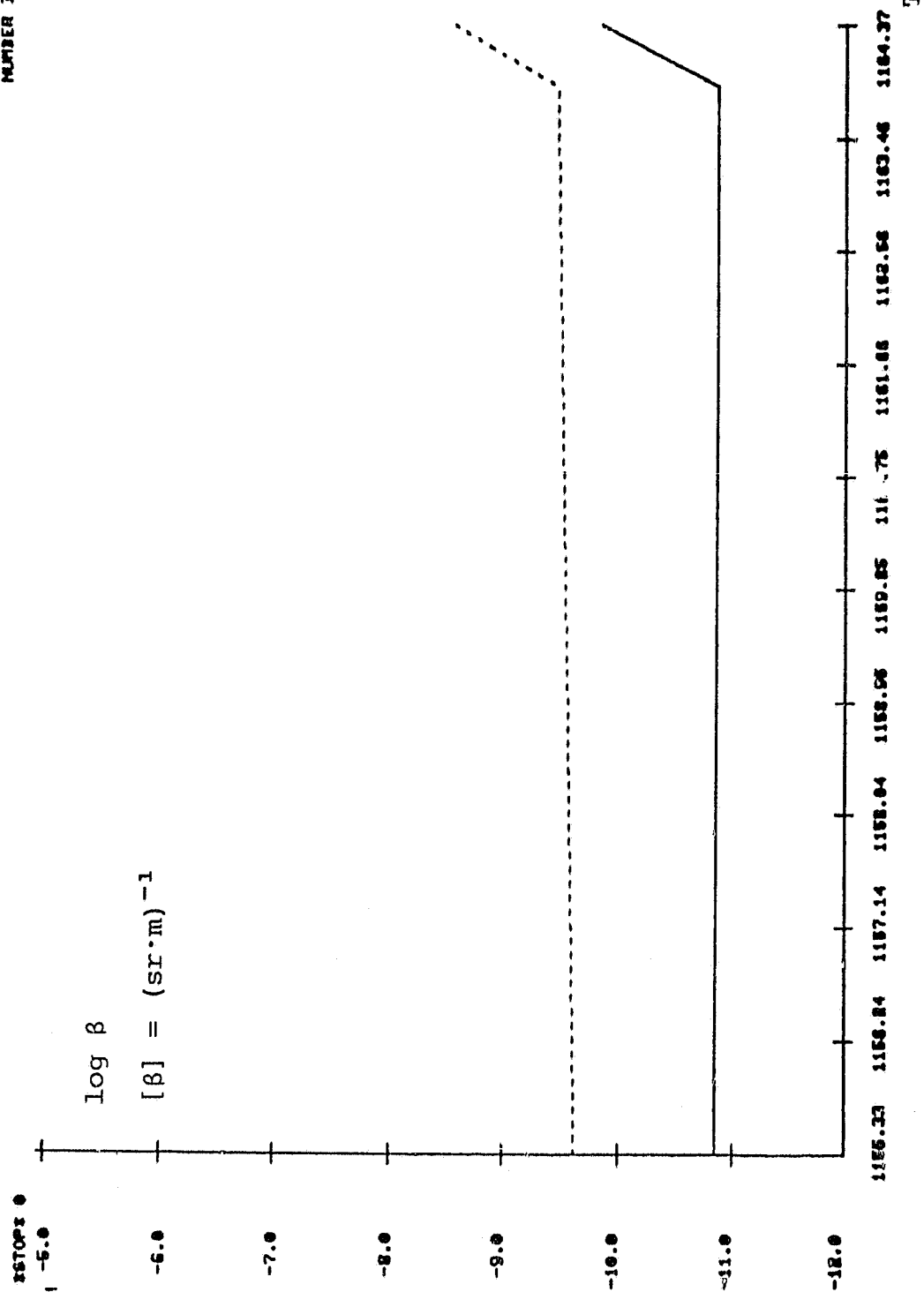


Fig. 16 Backscatter Coefficient β

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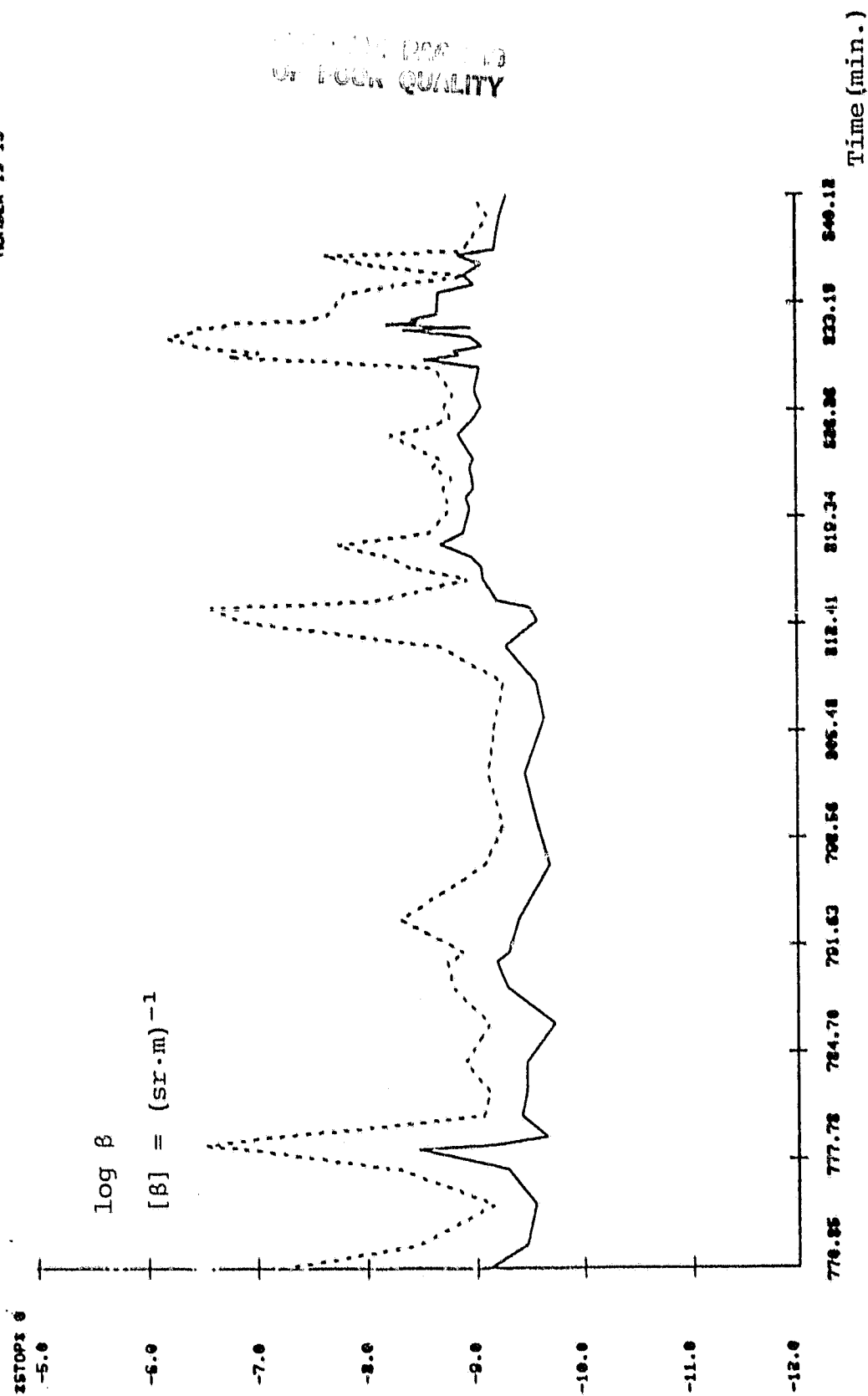


Fig. 17 Backscatter Coefficient β

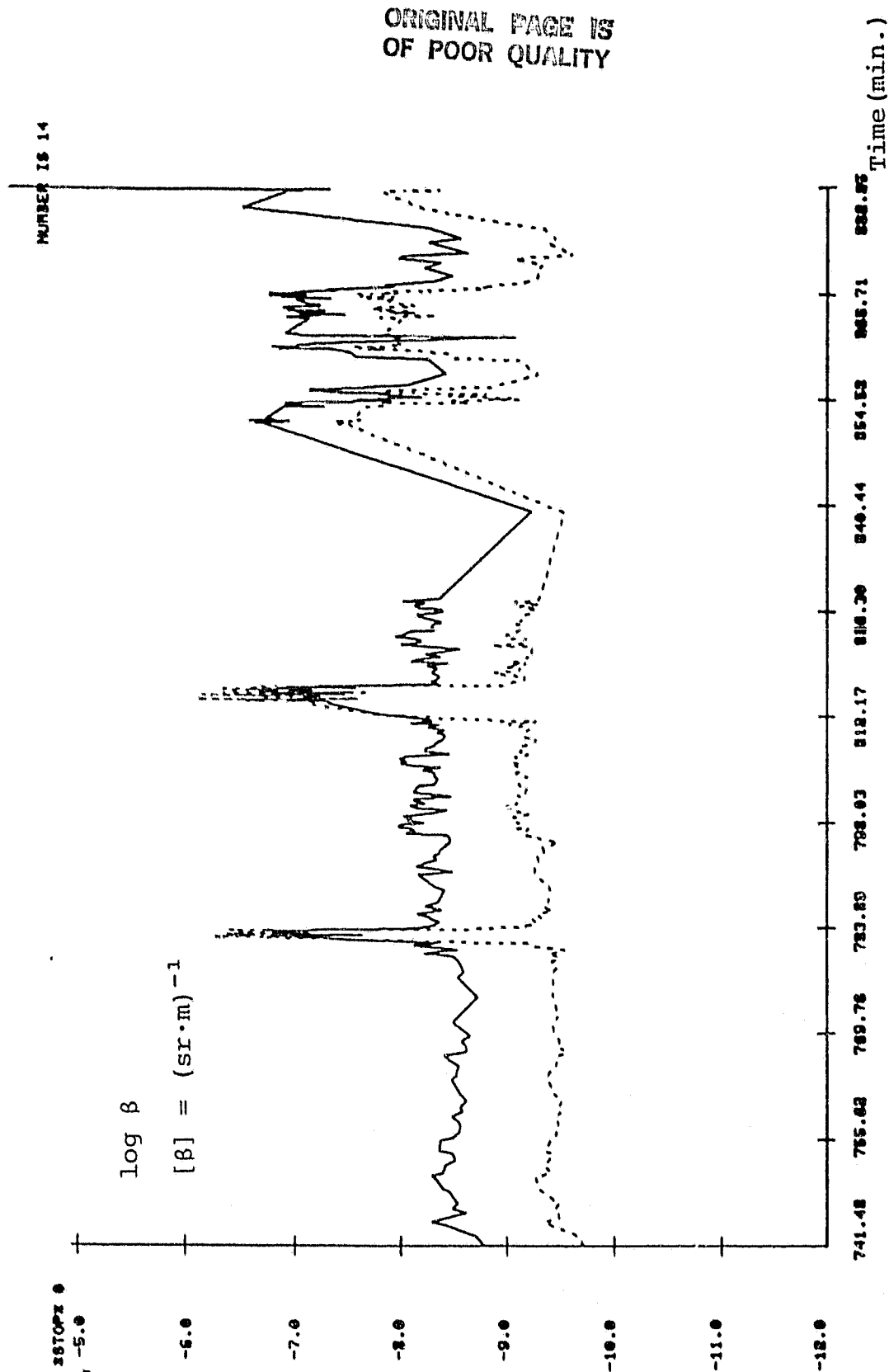


Fig. 18 Backscatter Coefficient β

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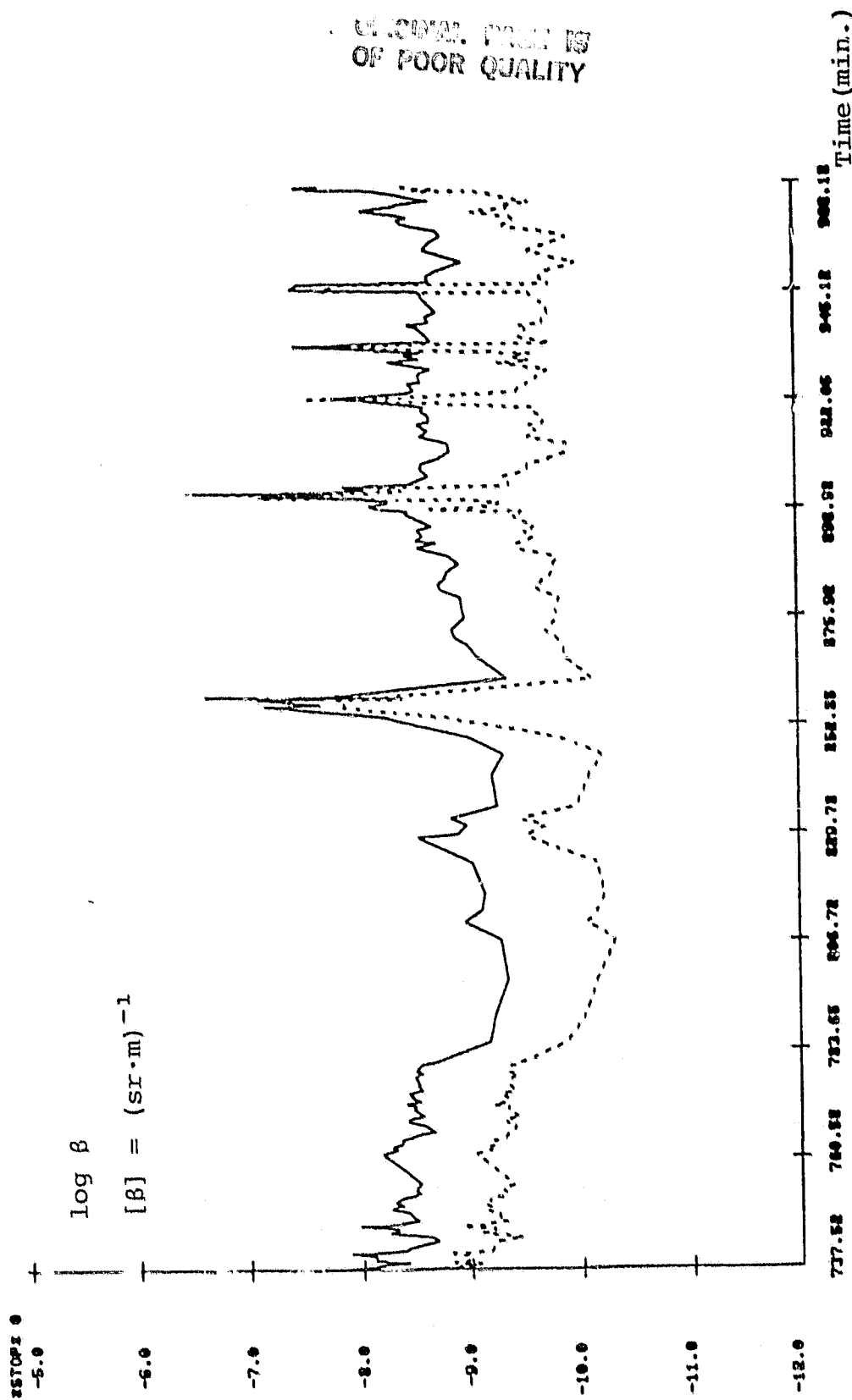


Fig. 19 Backscatter Coefficient β

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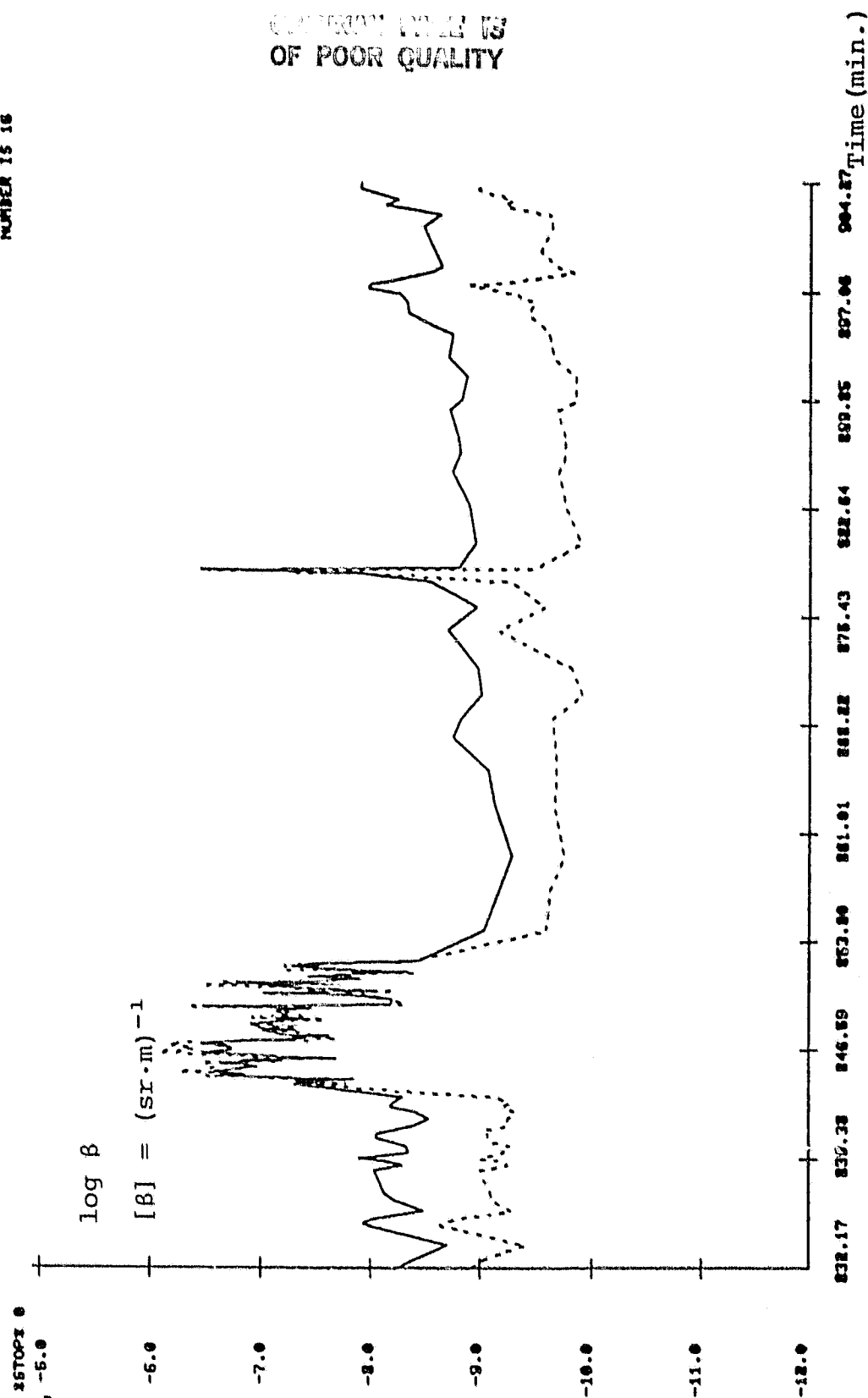


Fig. 20 Backscatter Coefficient β

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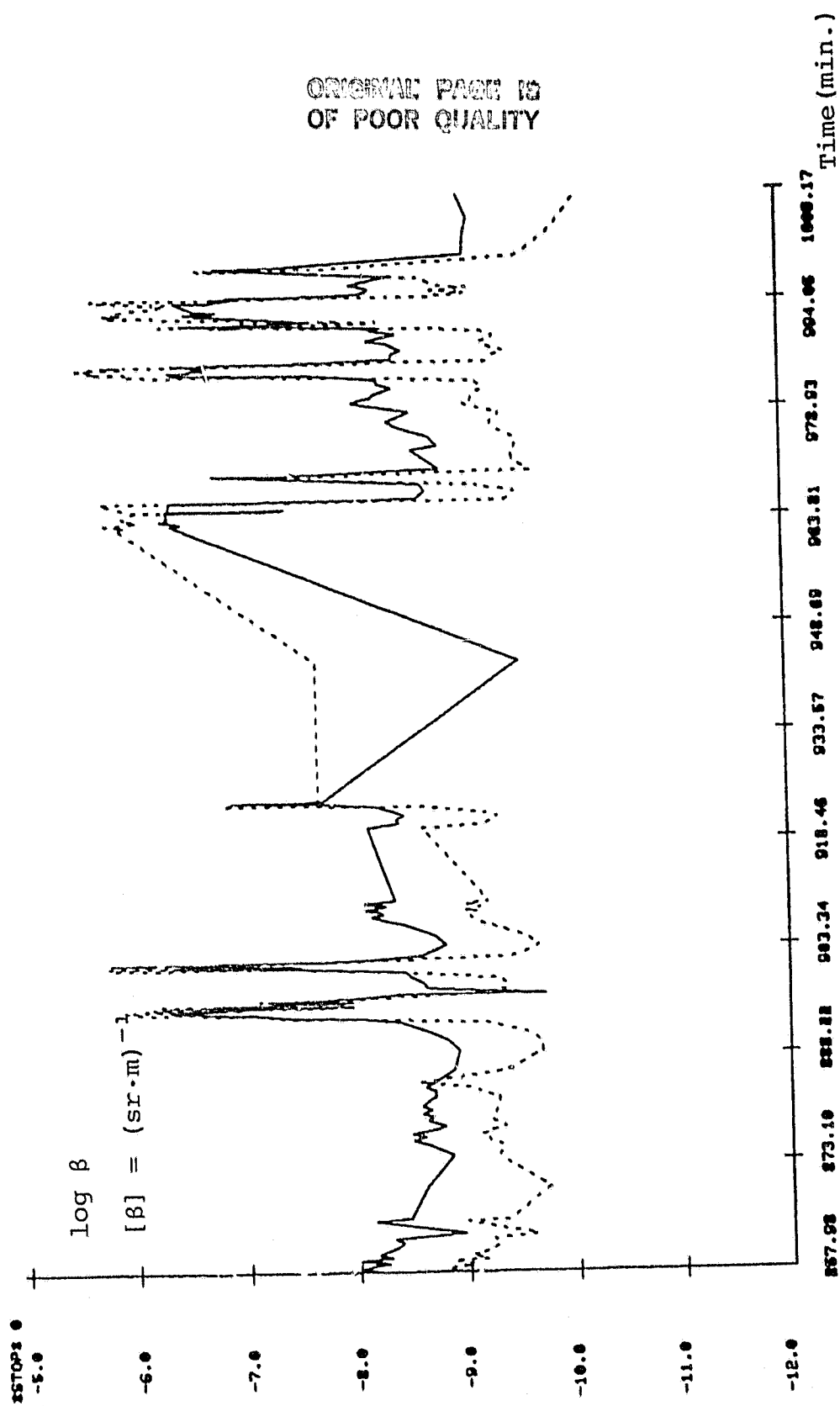


Fig. 21 Backscatter Coefficient β

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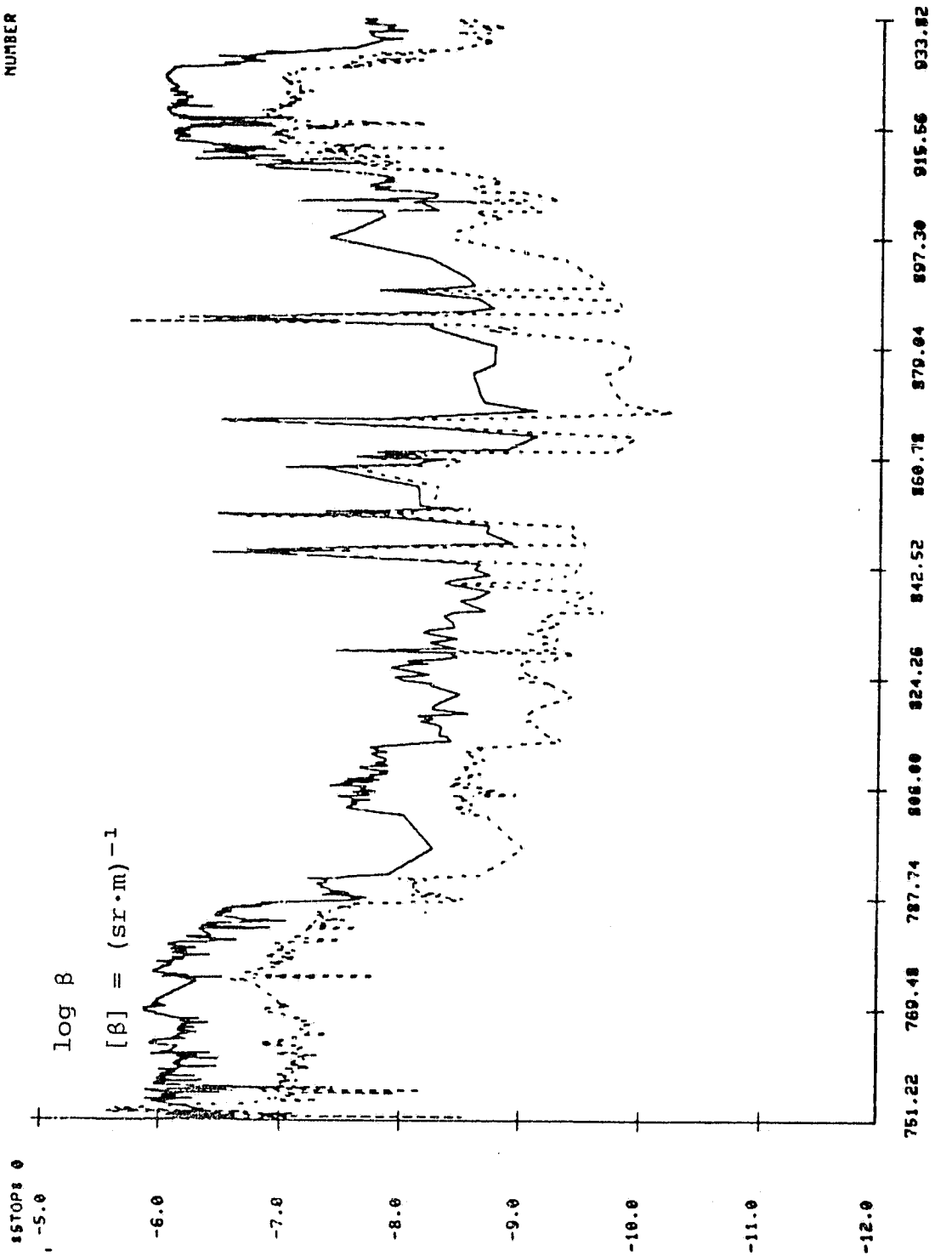


Fig. 22 Backscatter Coefficient β

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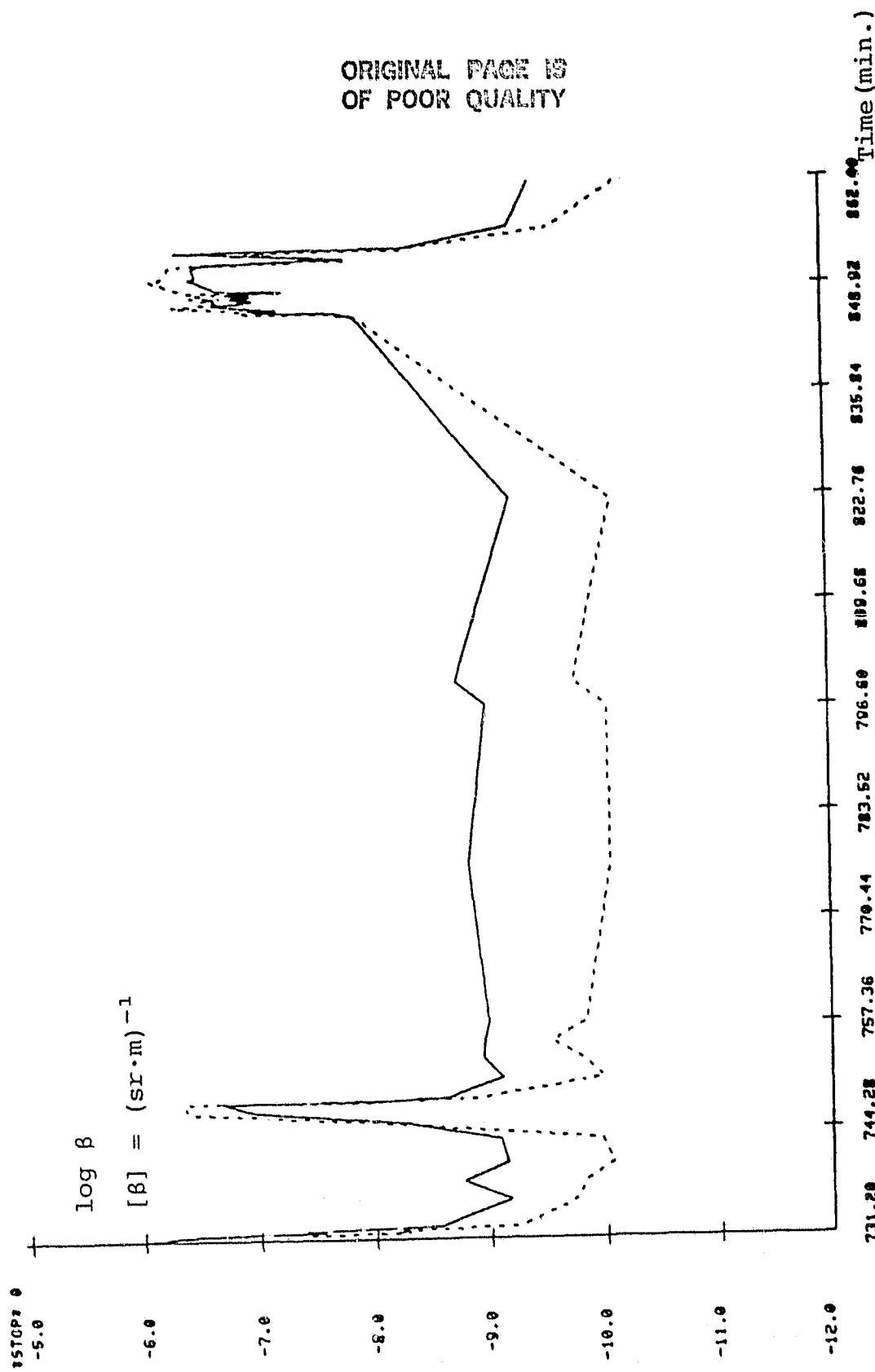


Fig. 23 Backscatter Coefficient β

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STOP 8

-5.0

$\log \beta$

$[\beta] = (\text{sr} \cdot \text{m})^{-1}$



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Time (min.)

Fig. 24 Backscatter Coefficient β

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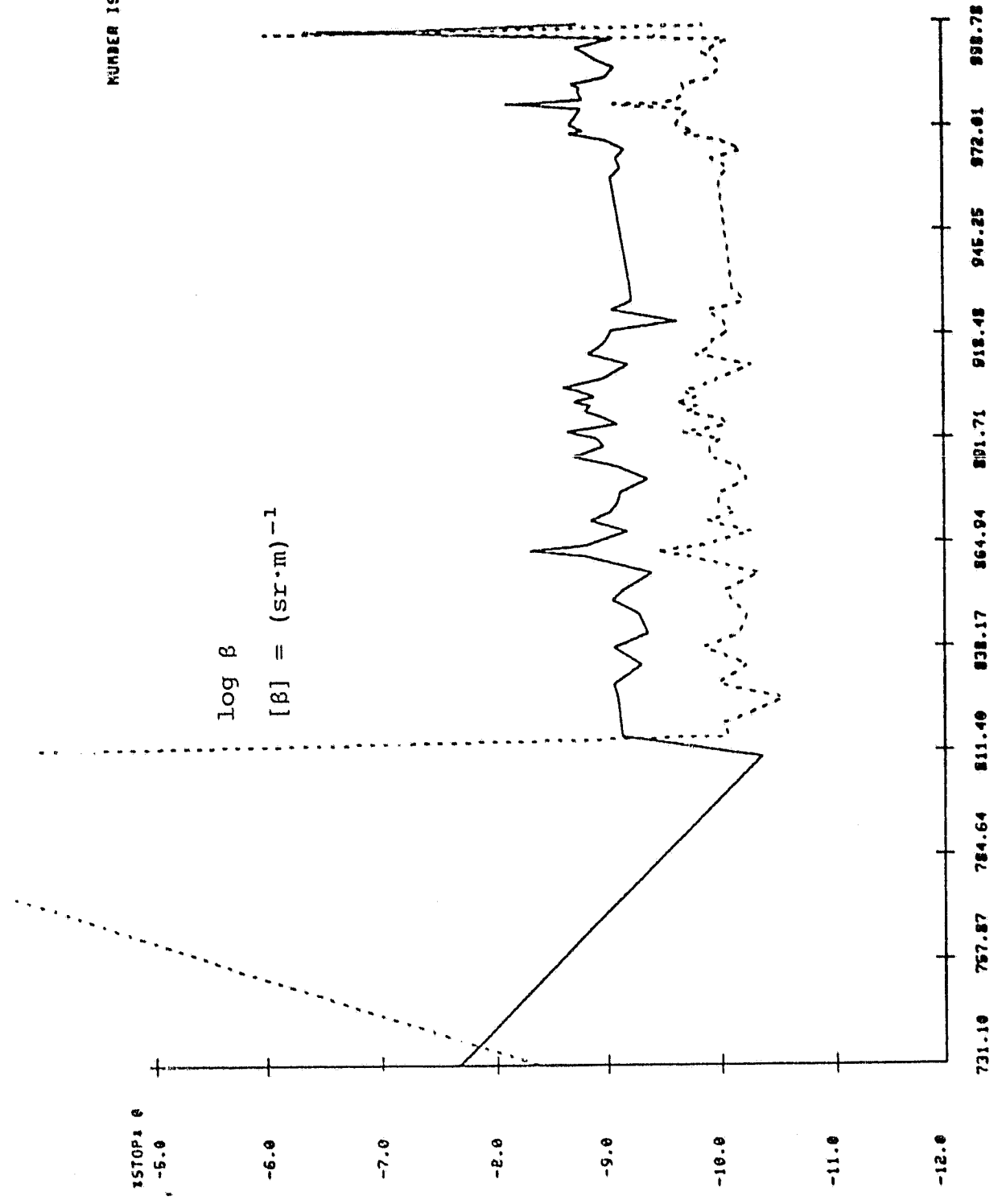


Fig. 25 Backscatter Coefficient β

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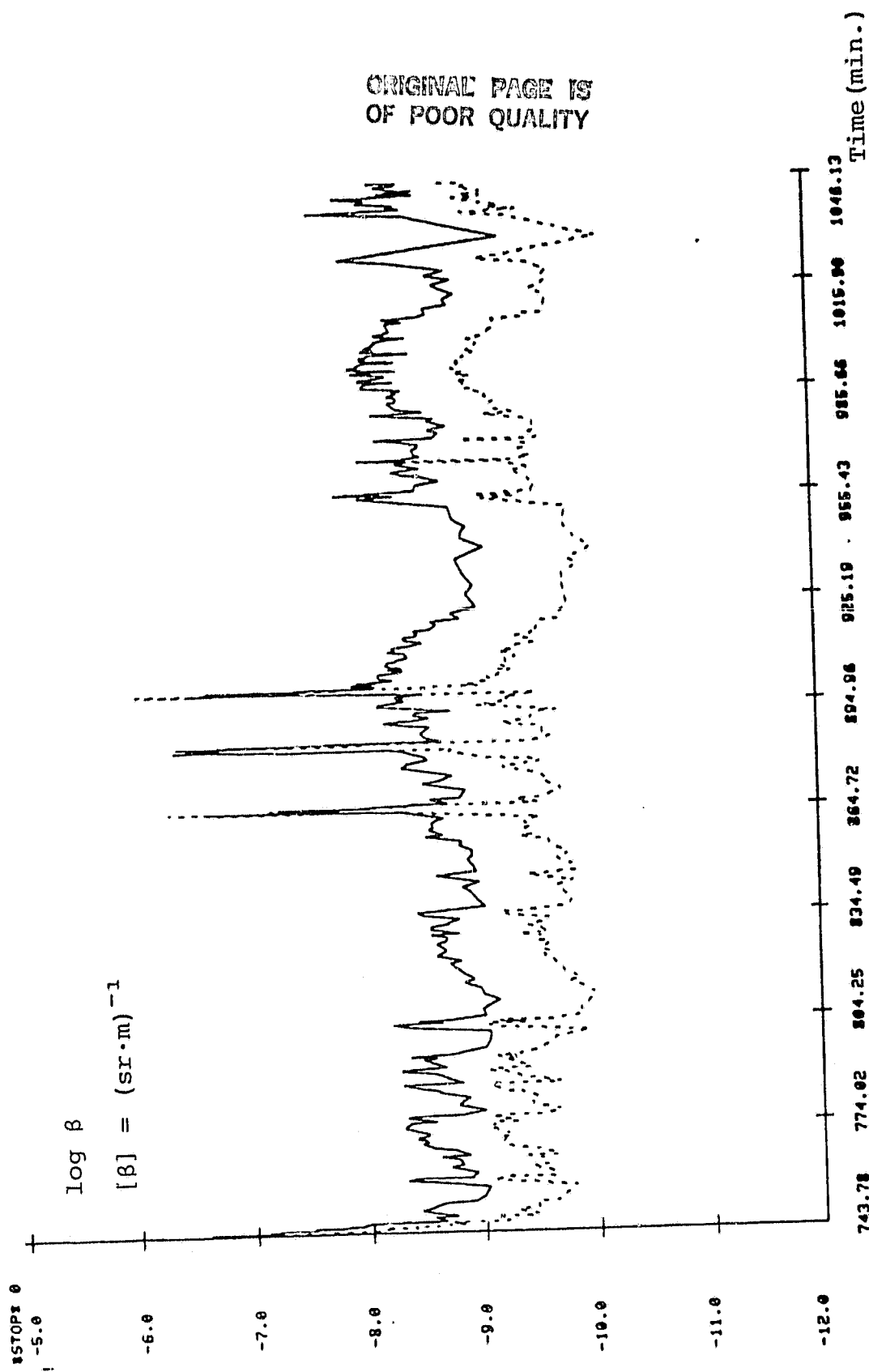


Fig. 26 Backscatter Coefficient β

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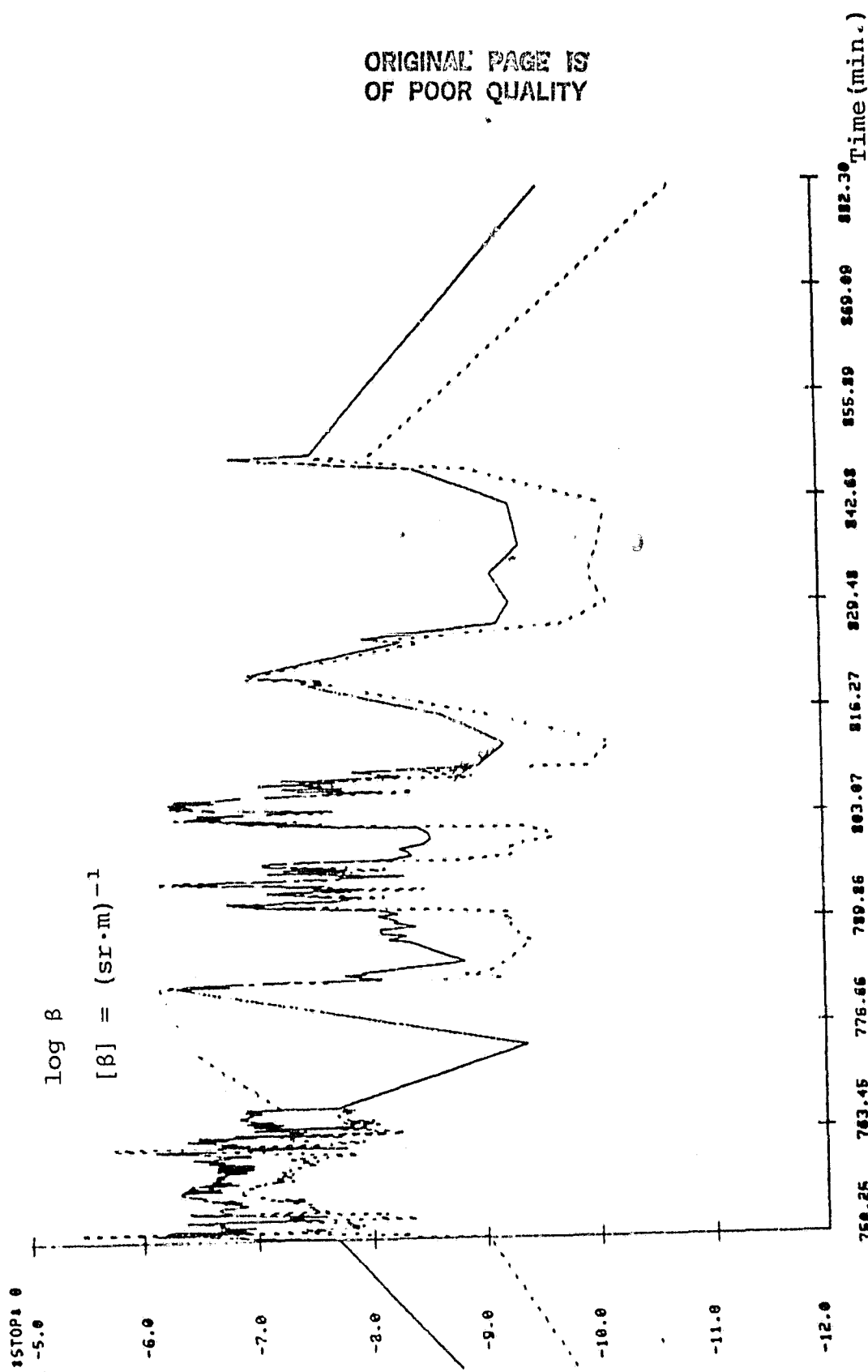


Fig. 27 Backscatter Coefficient β

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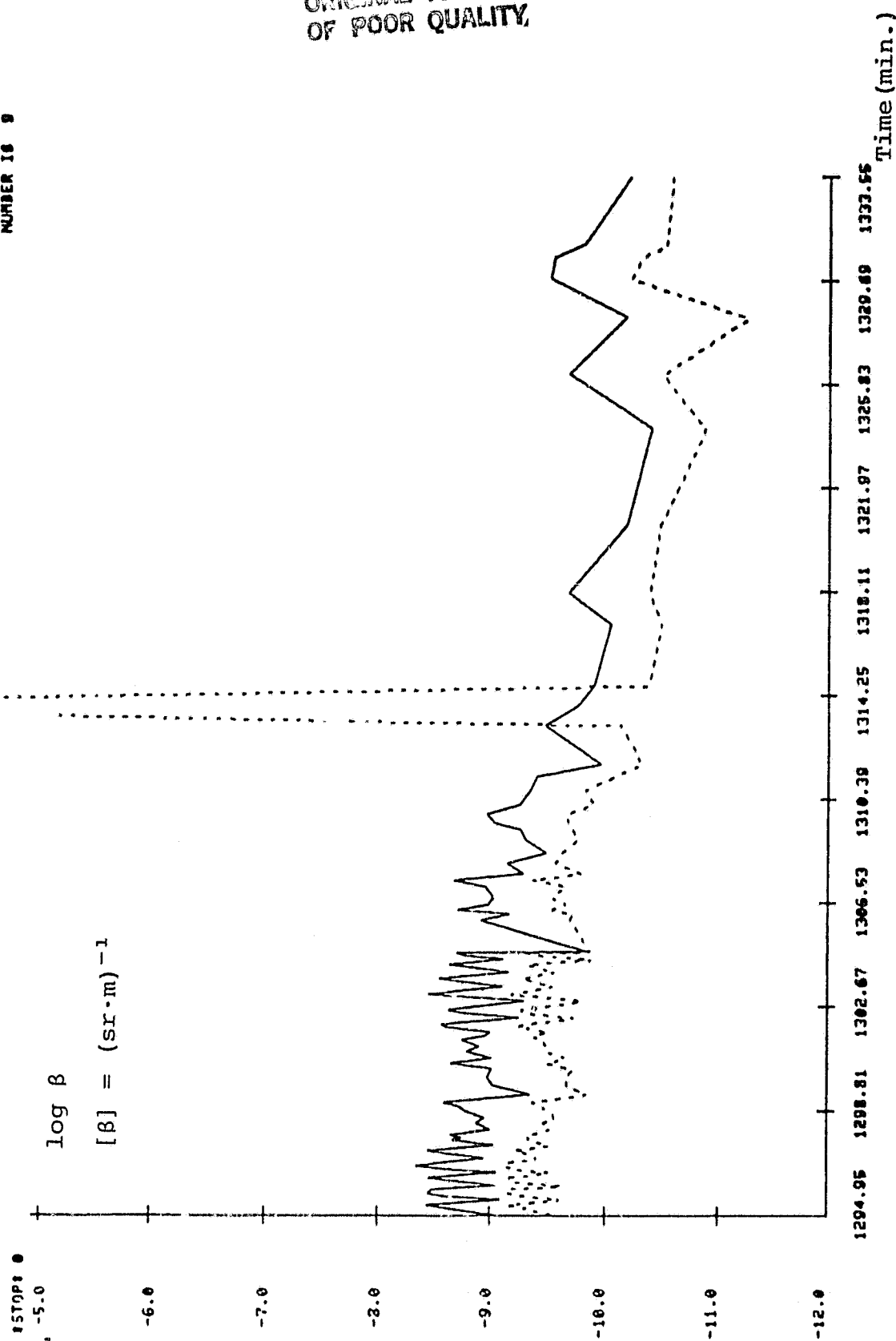


Fig. 27-A Backscatter Coefficient β

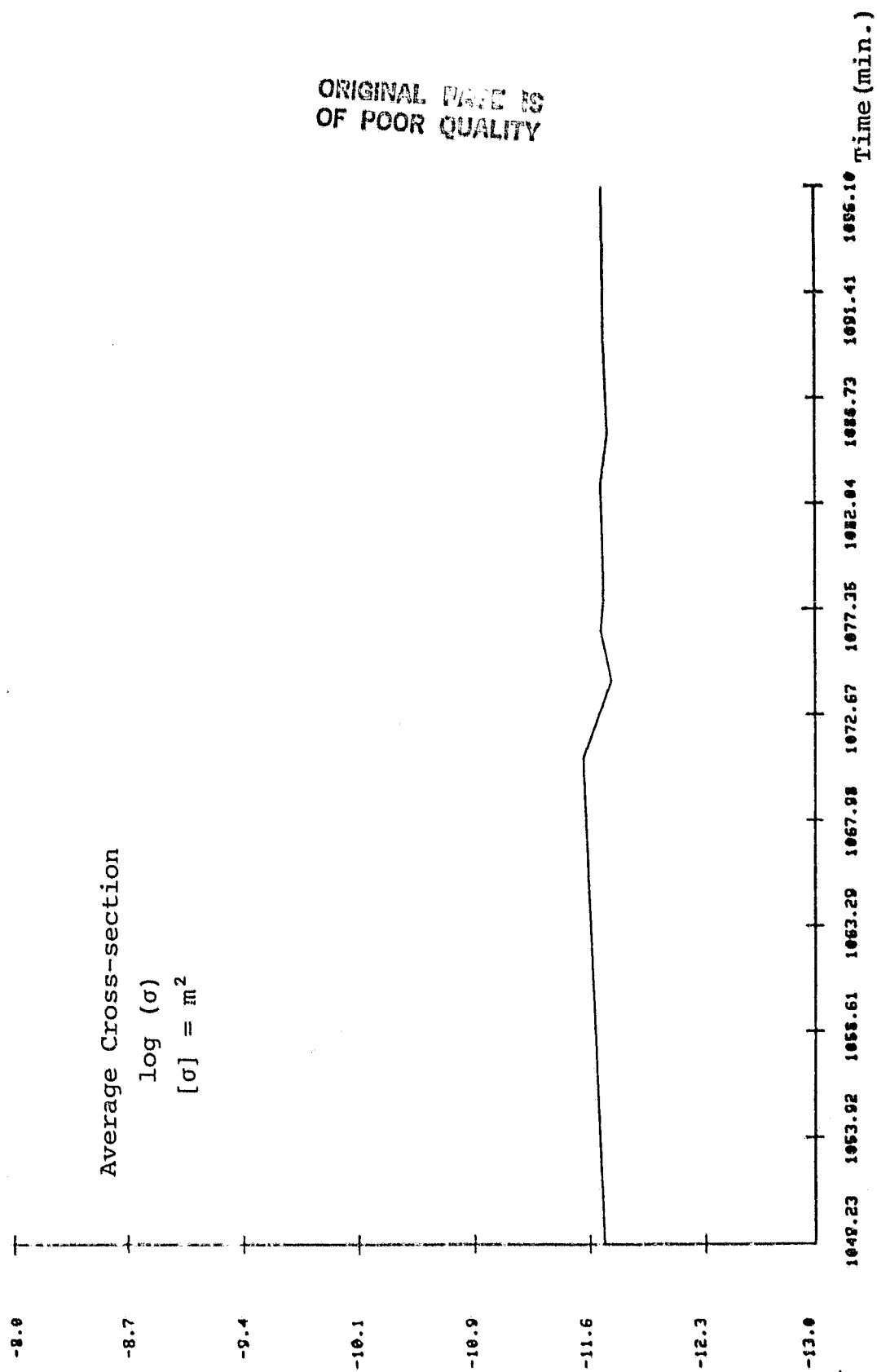


Fig. 28 Average Cross-section σ

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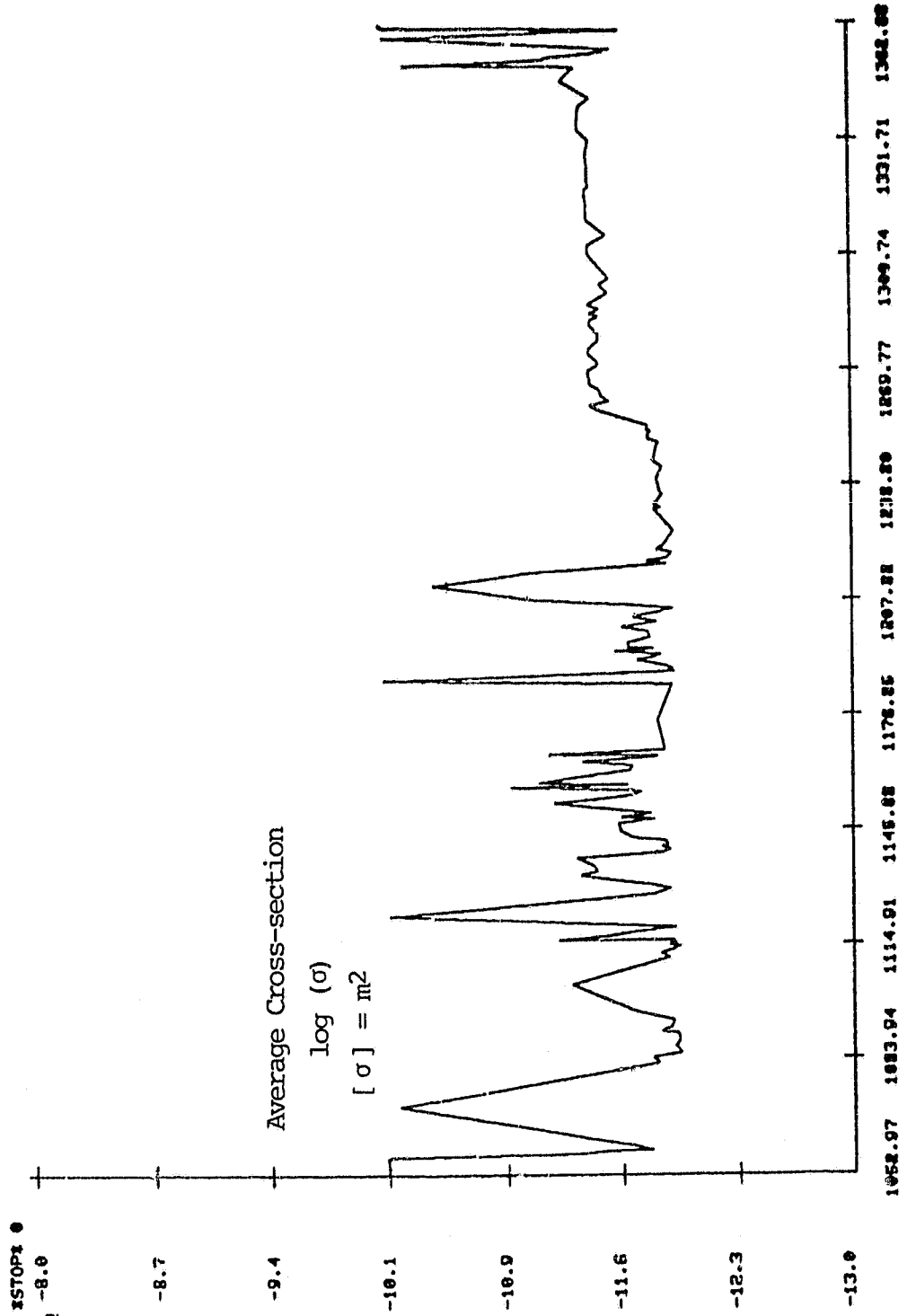


Fig.29 Average Cross-section σ

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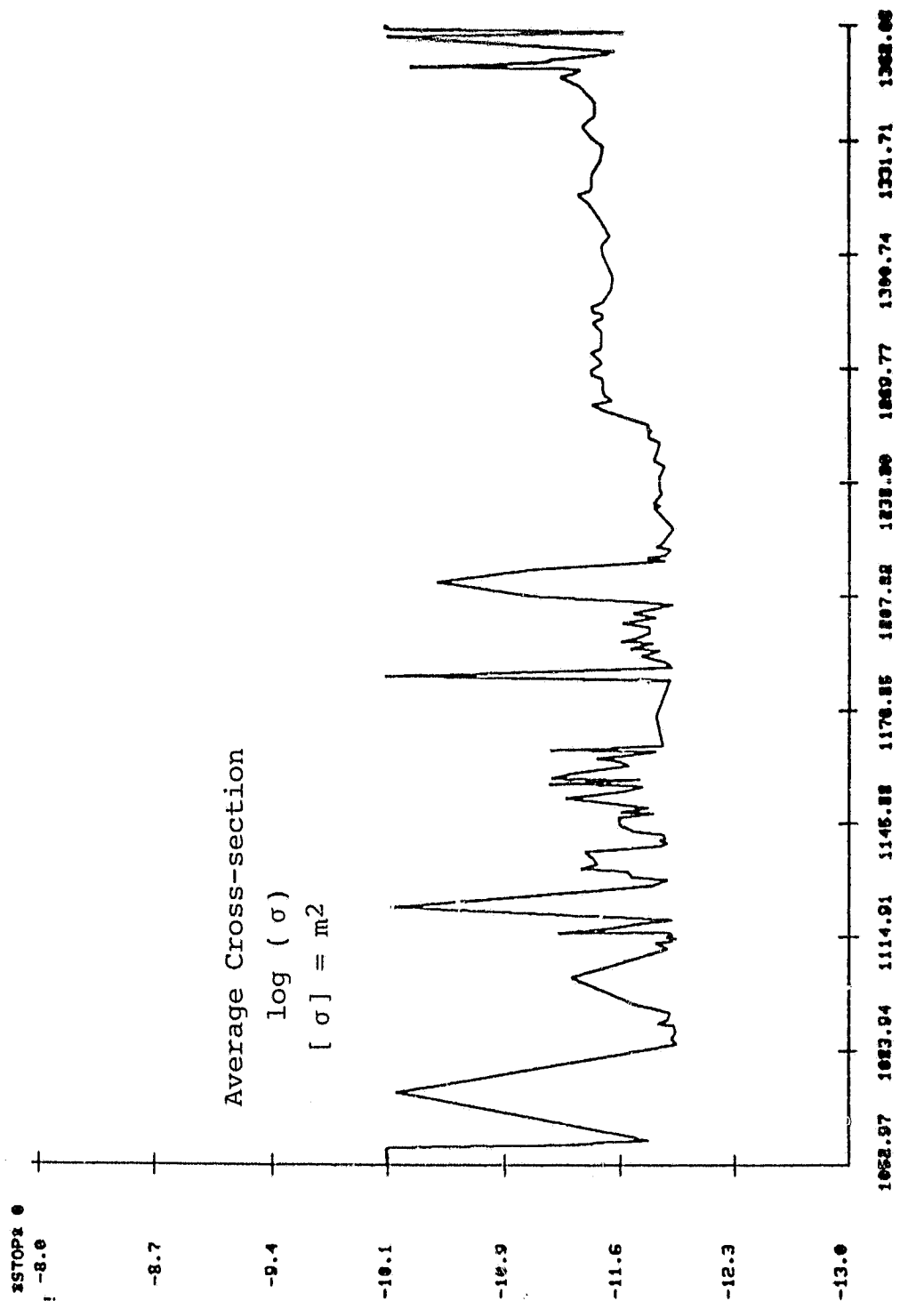


Fig.30 Average Cross Section σ

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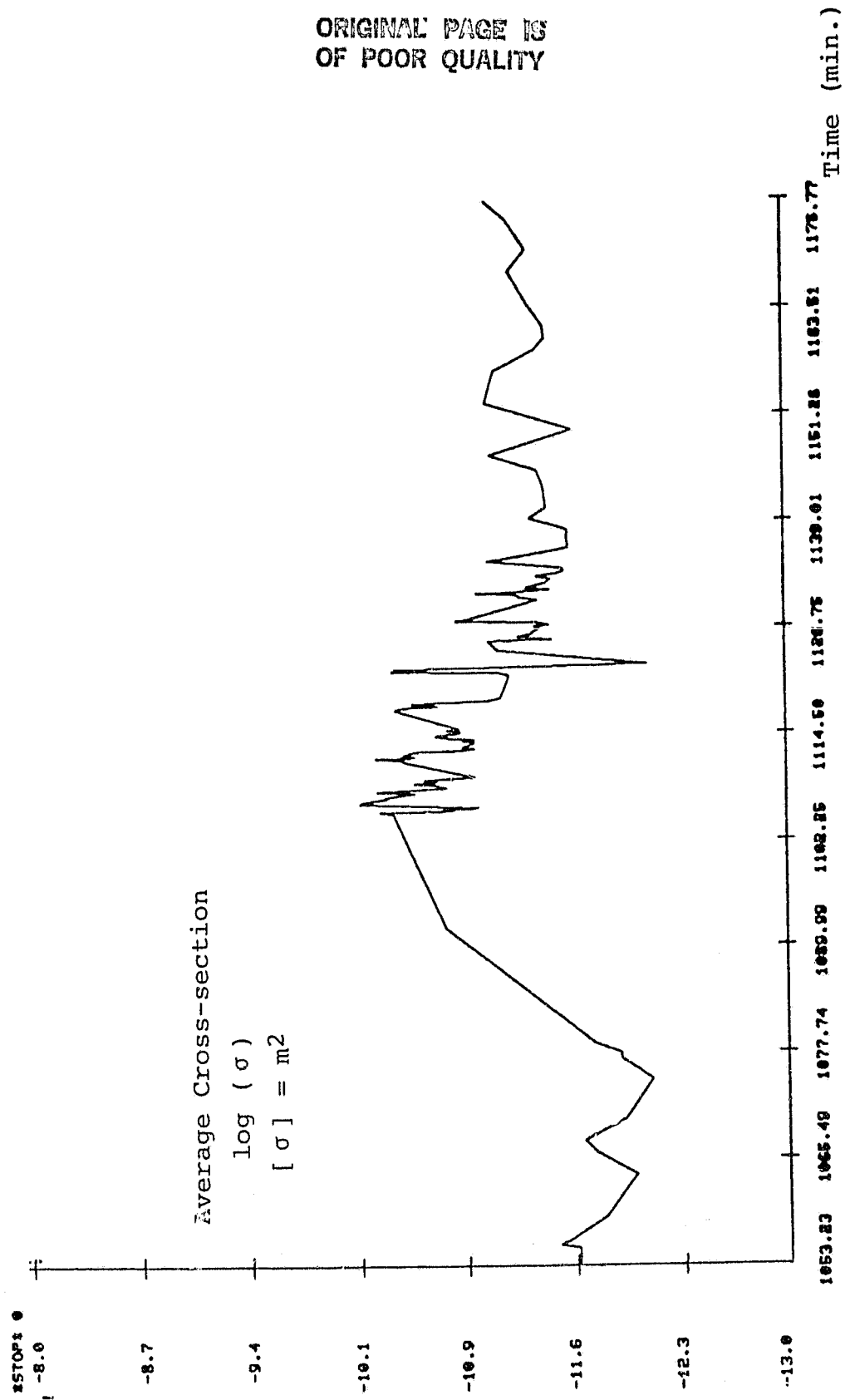


Fig.31 Average Cross-section σ

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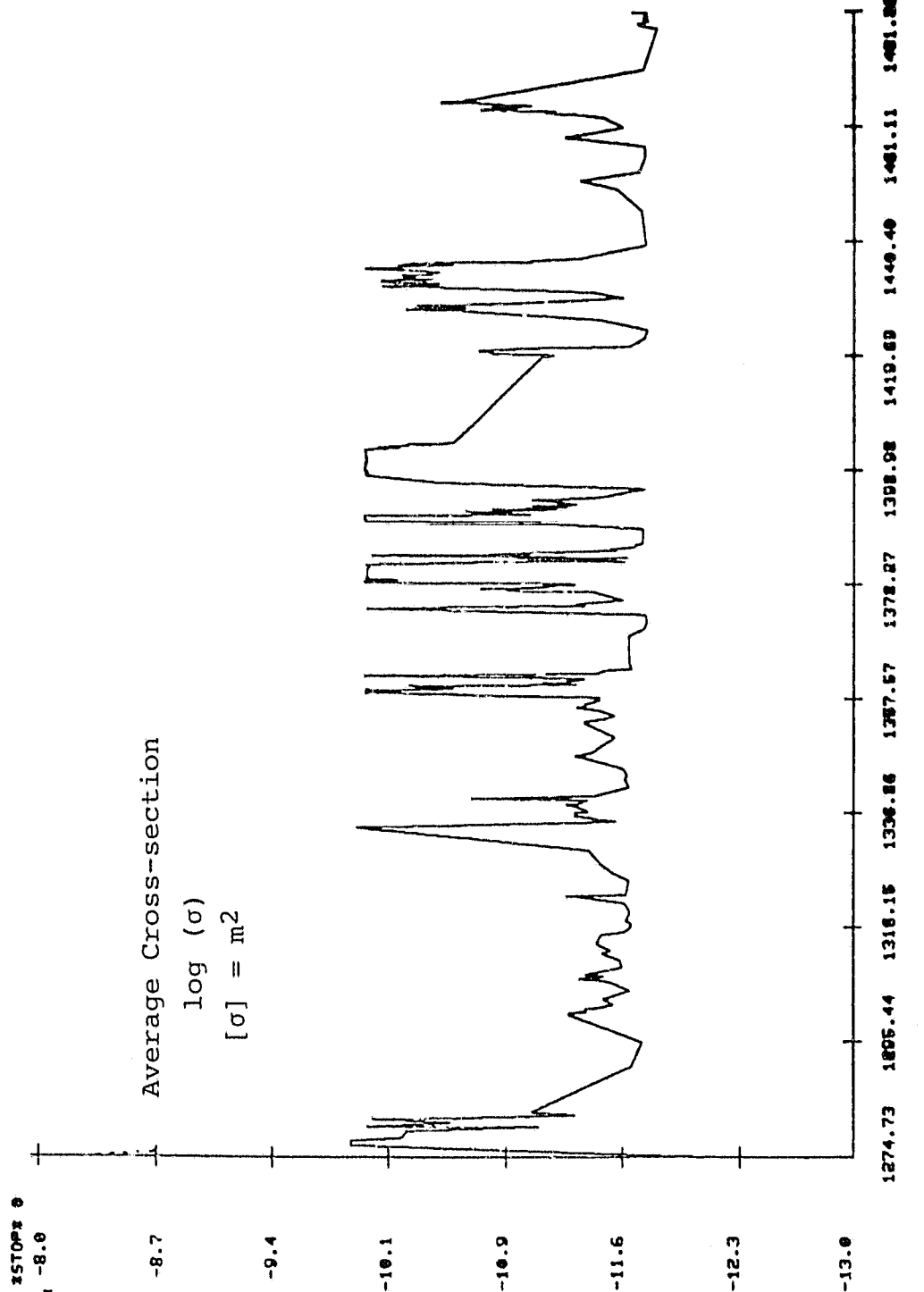


Fig. 32 Average Cross-section σ

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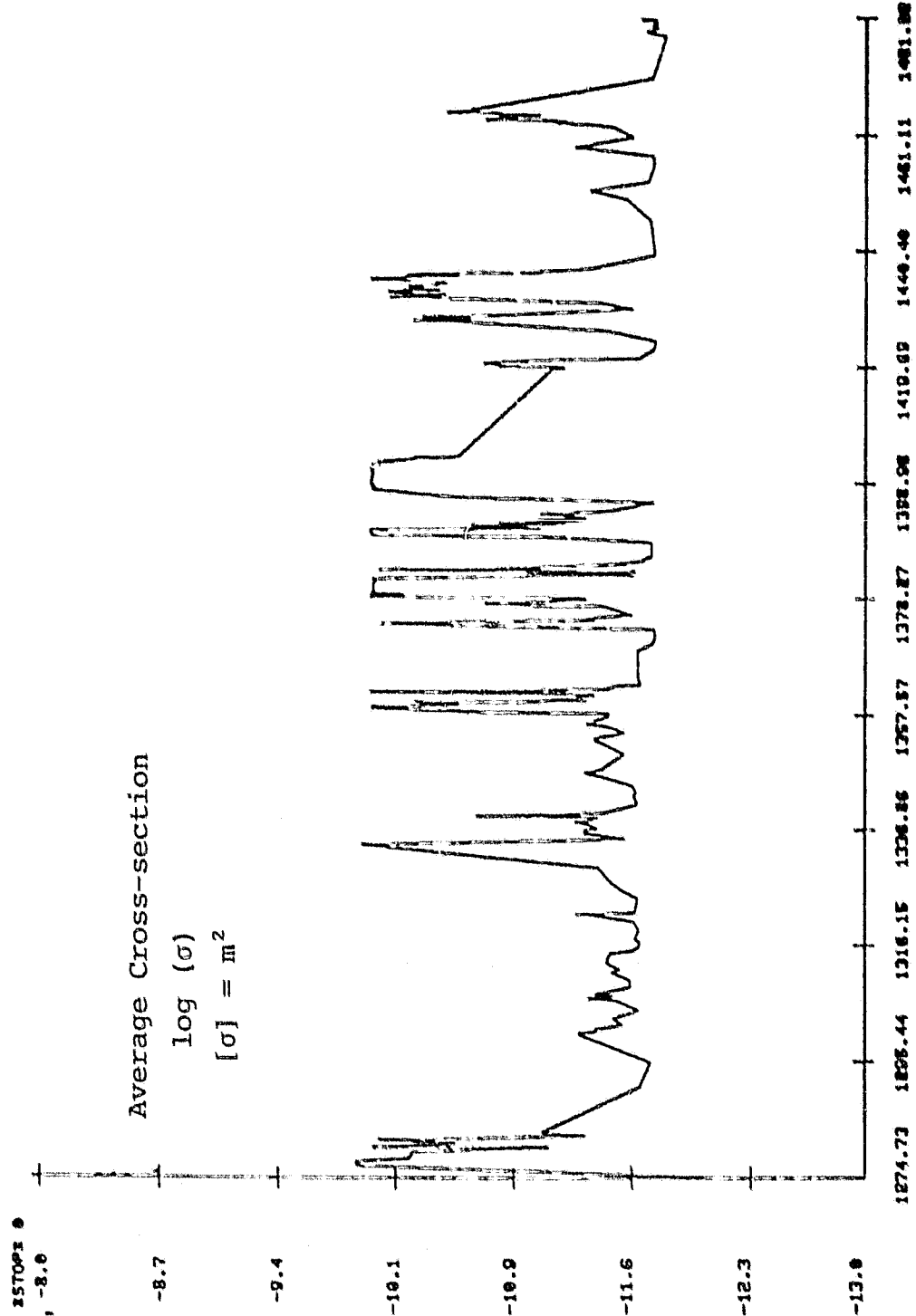


Fig. 33 Average Cross-section σ

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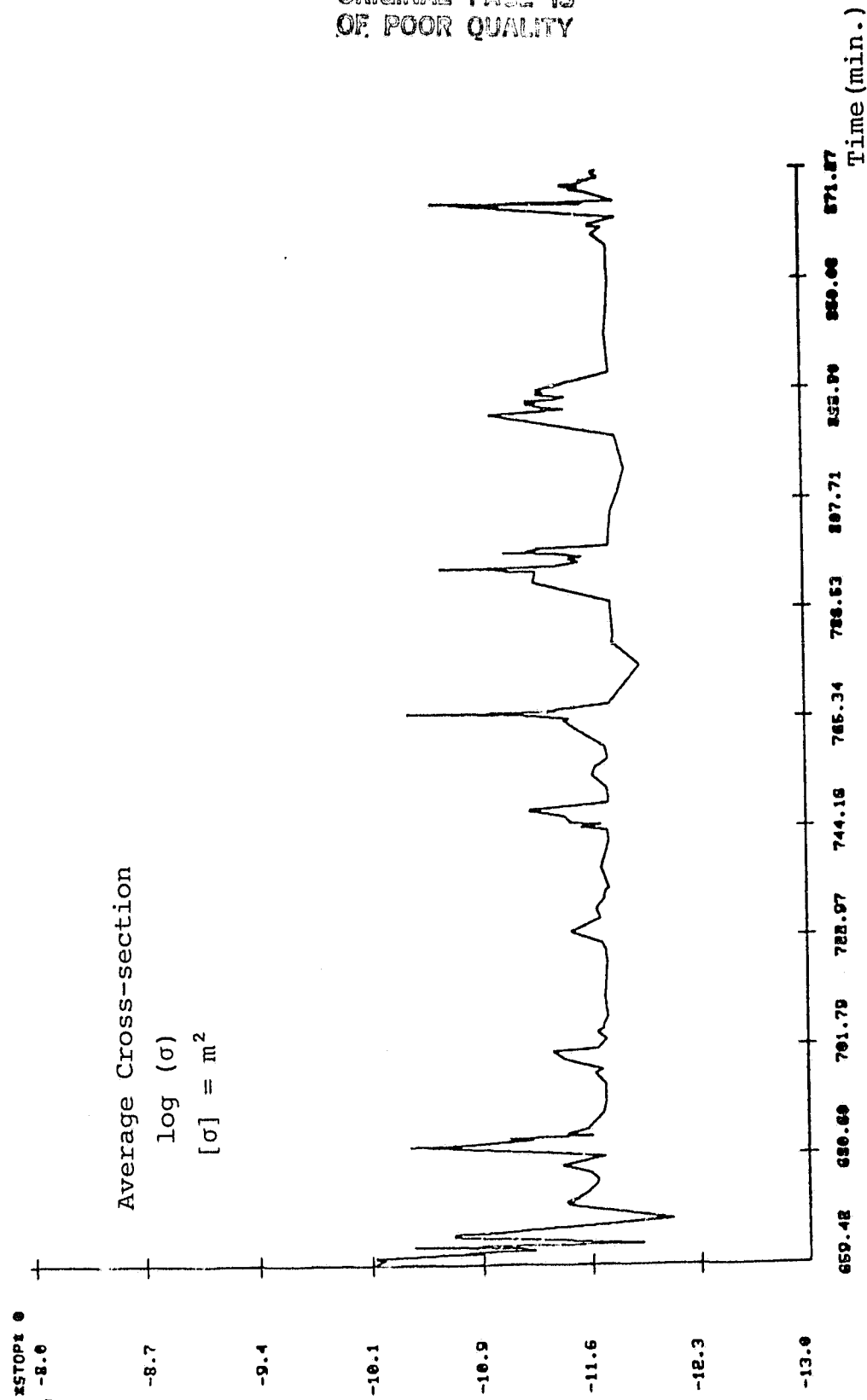


Fig. 34 Average Cross-section σ

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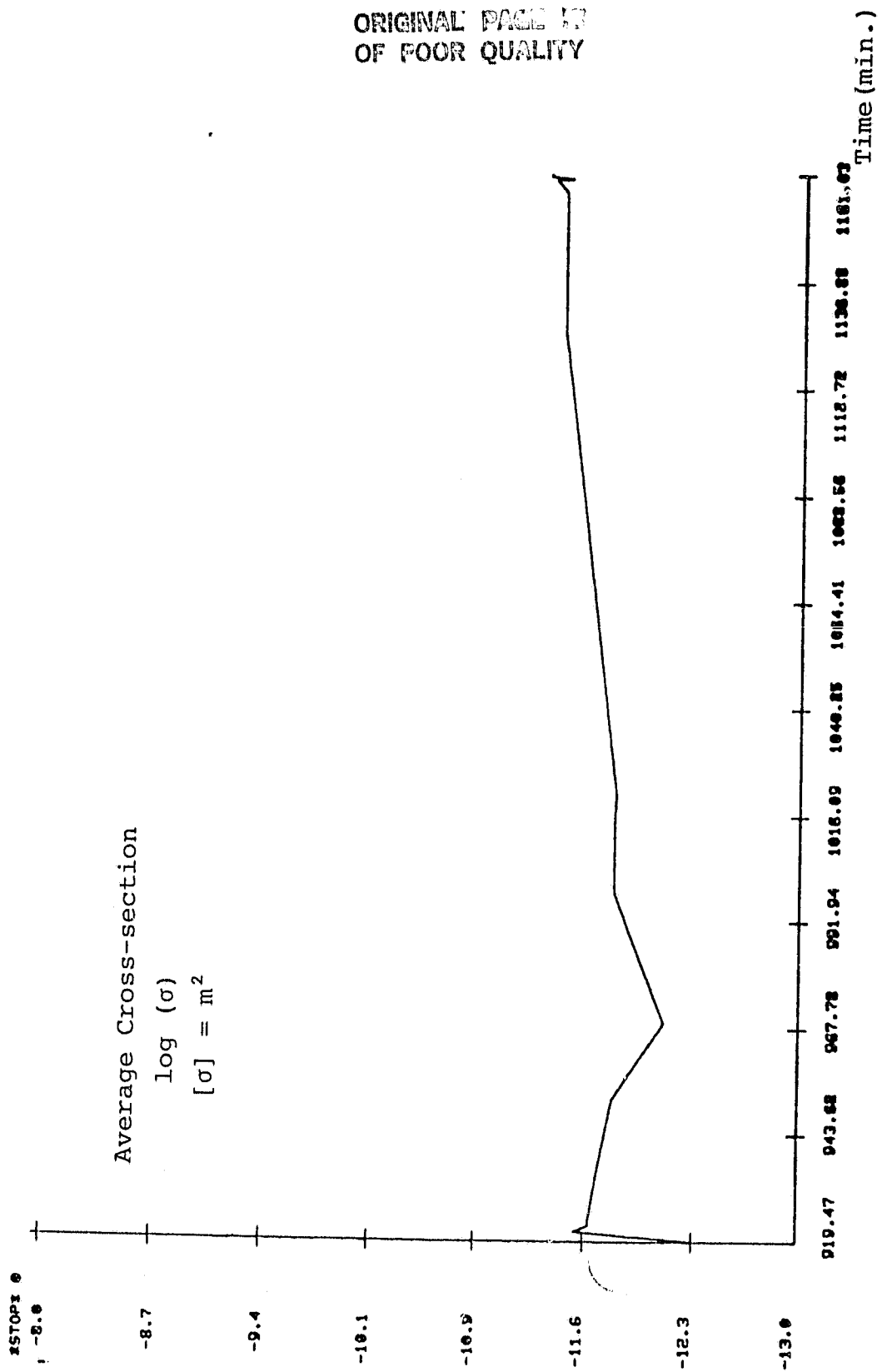


Fig. 35 Average Cross-section σ

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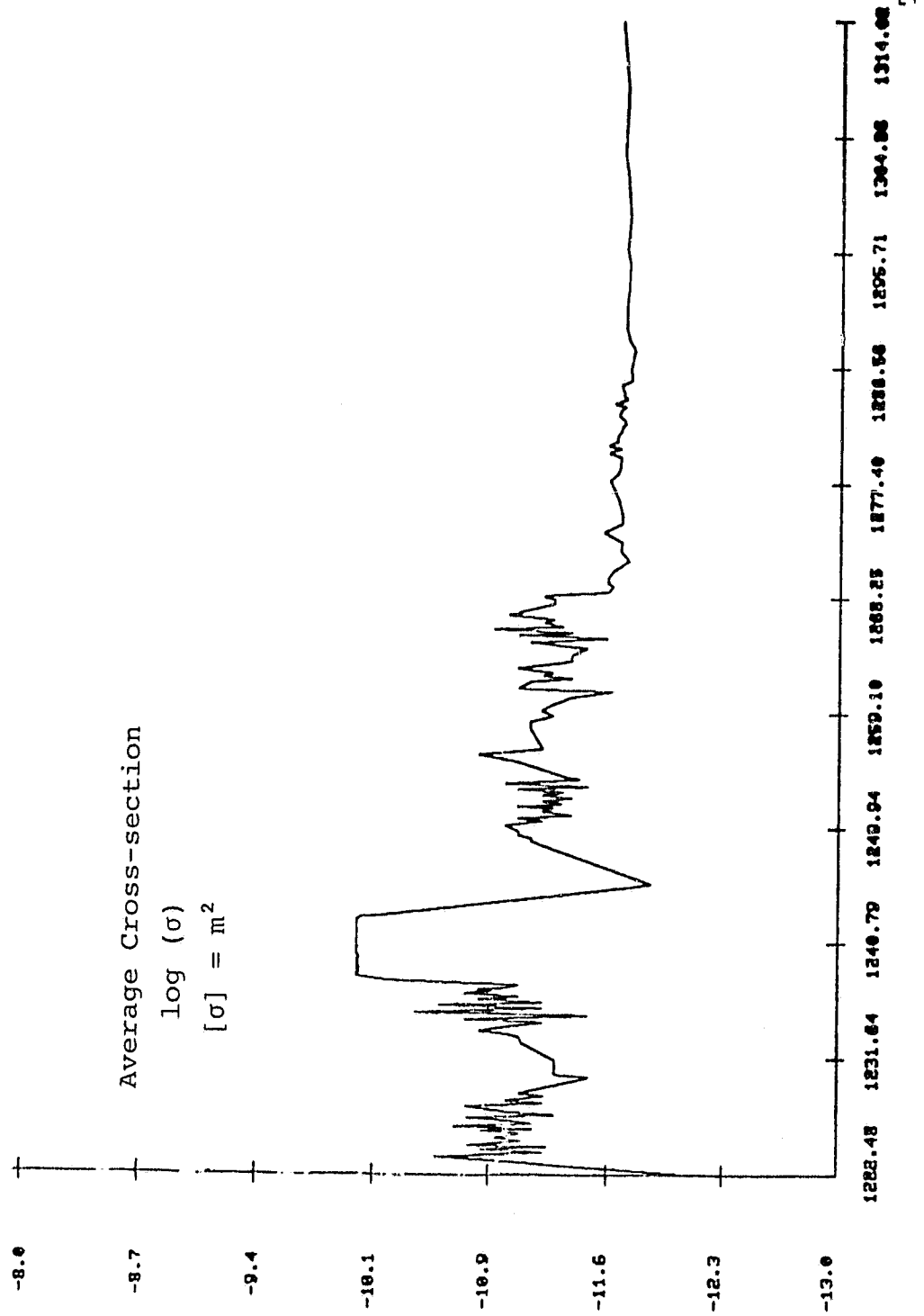


Fig. 36 Average Cross-section σ

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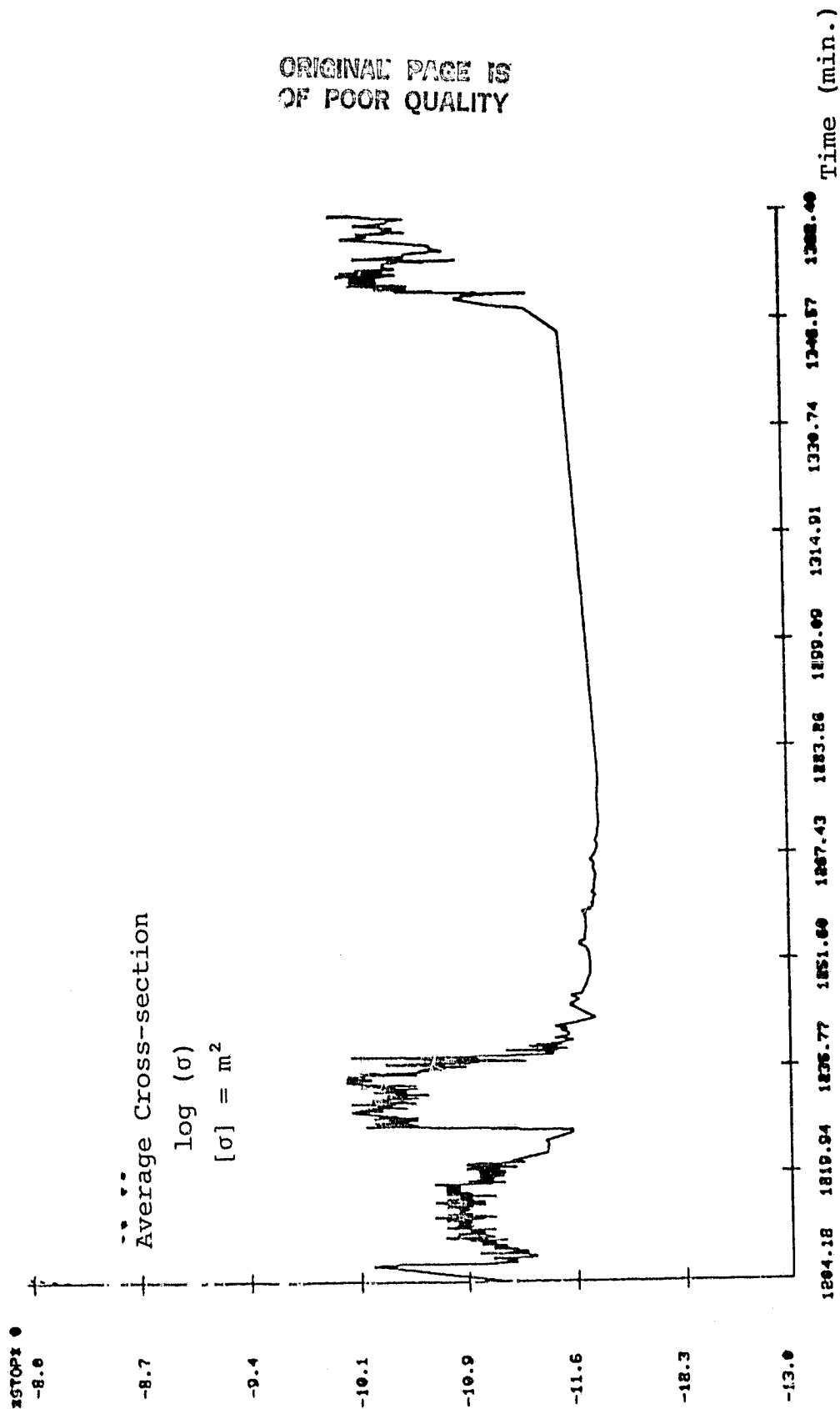


Fig. 37 Average Cross-section σ

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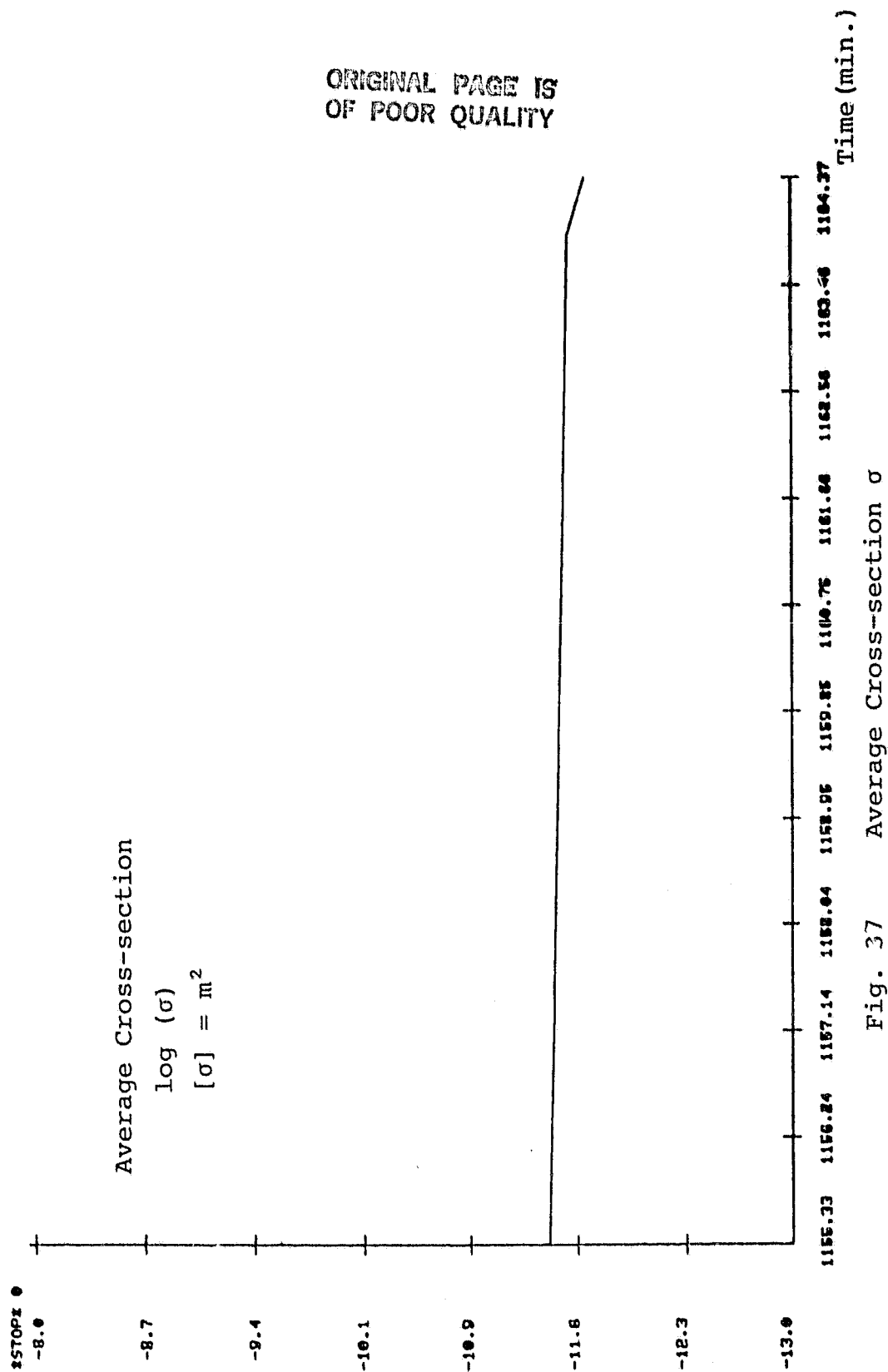


Fig. 37 Average Cross-section σ

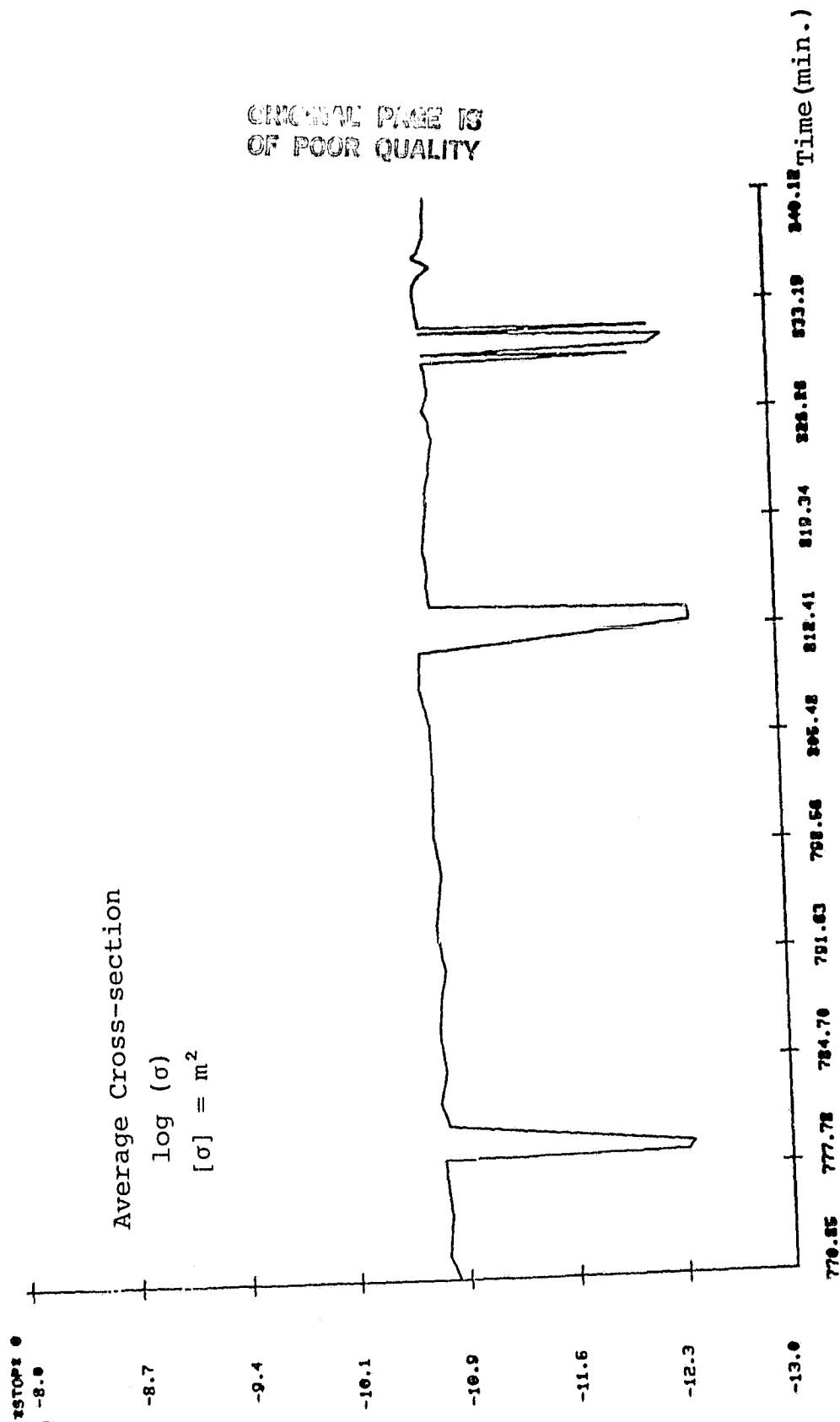


Fig. 39 Average Cross-section σ

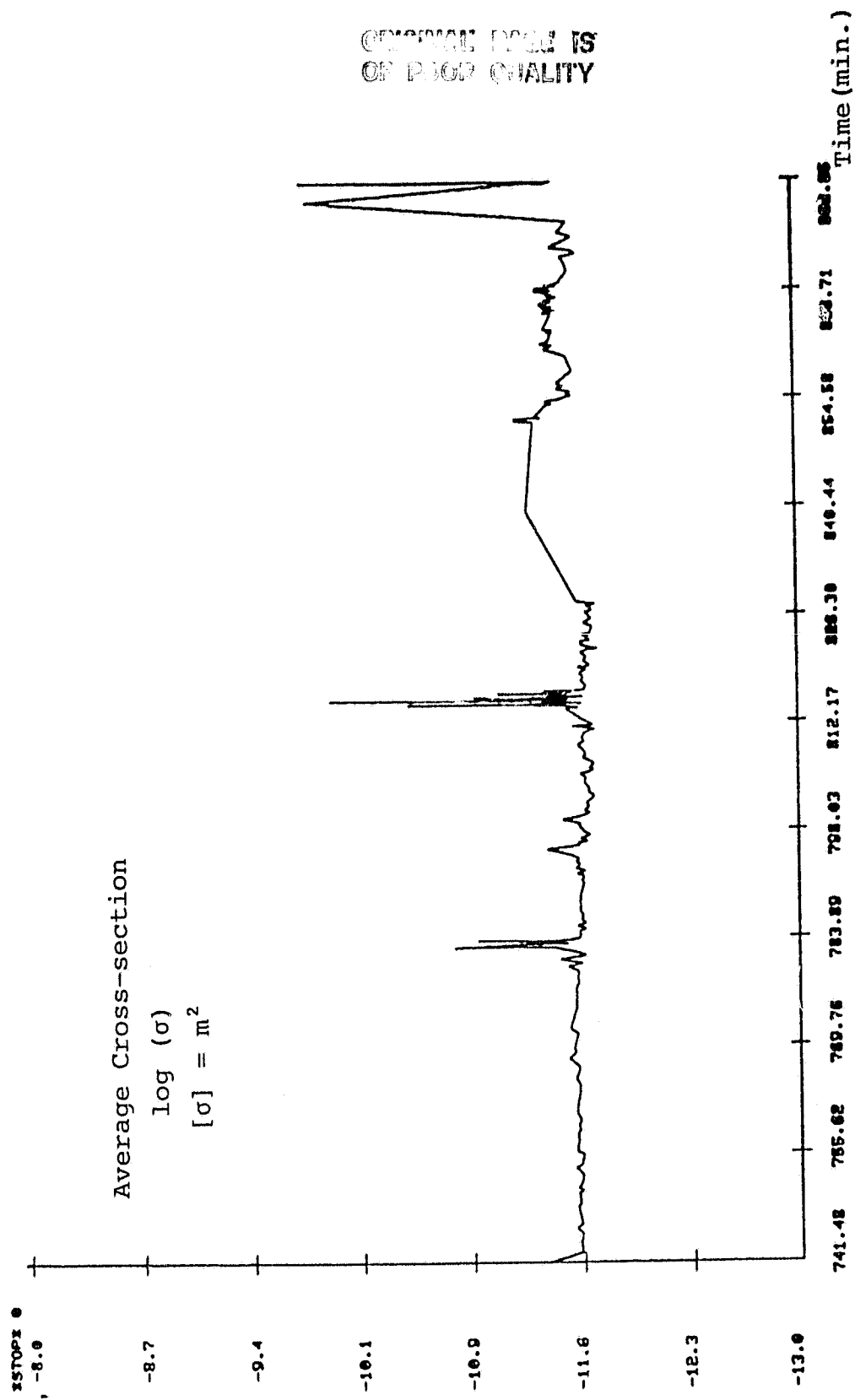


Fig. 40 Average Cross-section σ

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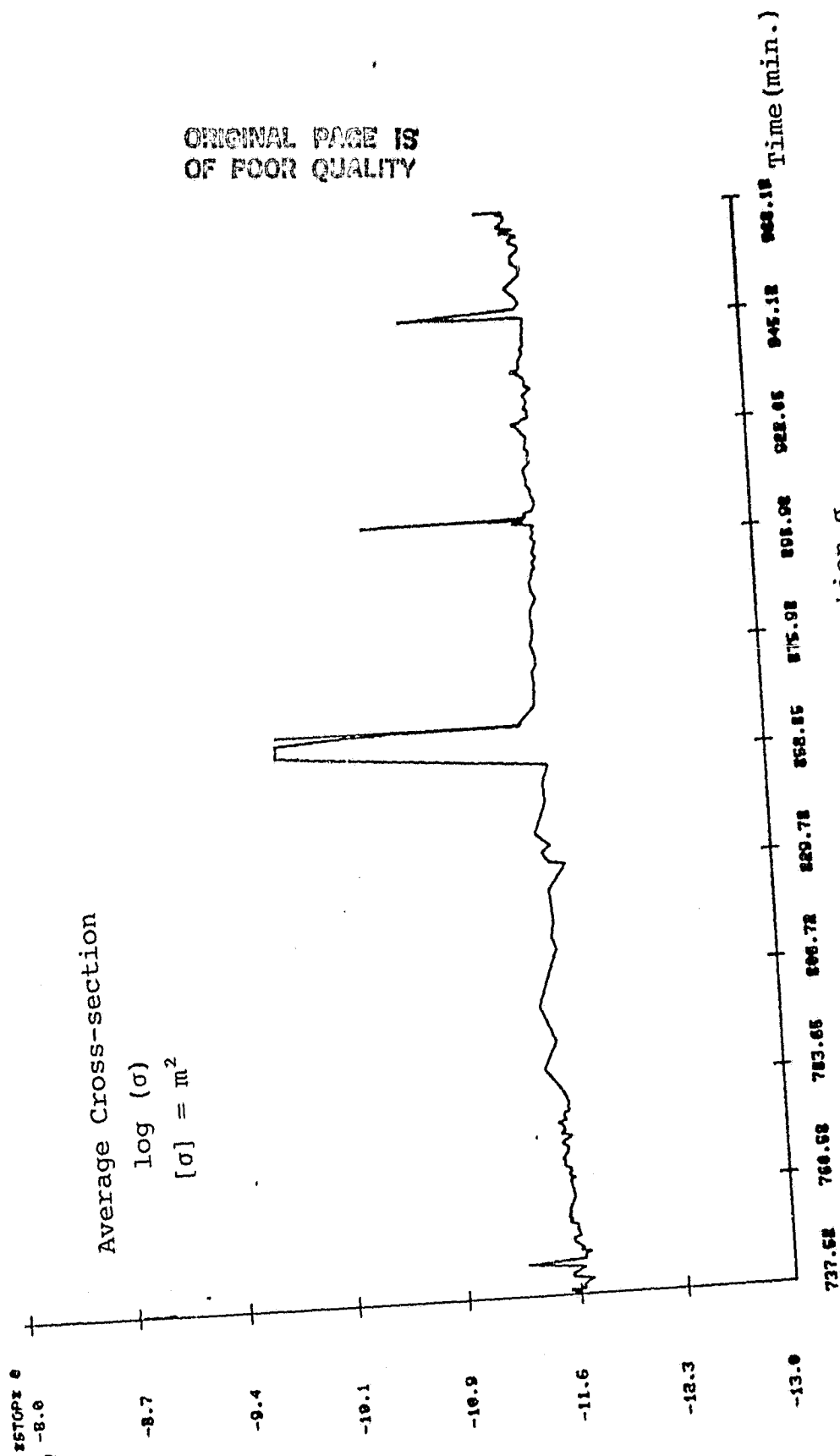


Fig. 41 Average Cross-section σ

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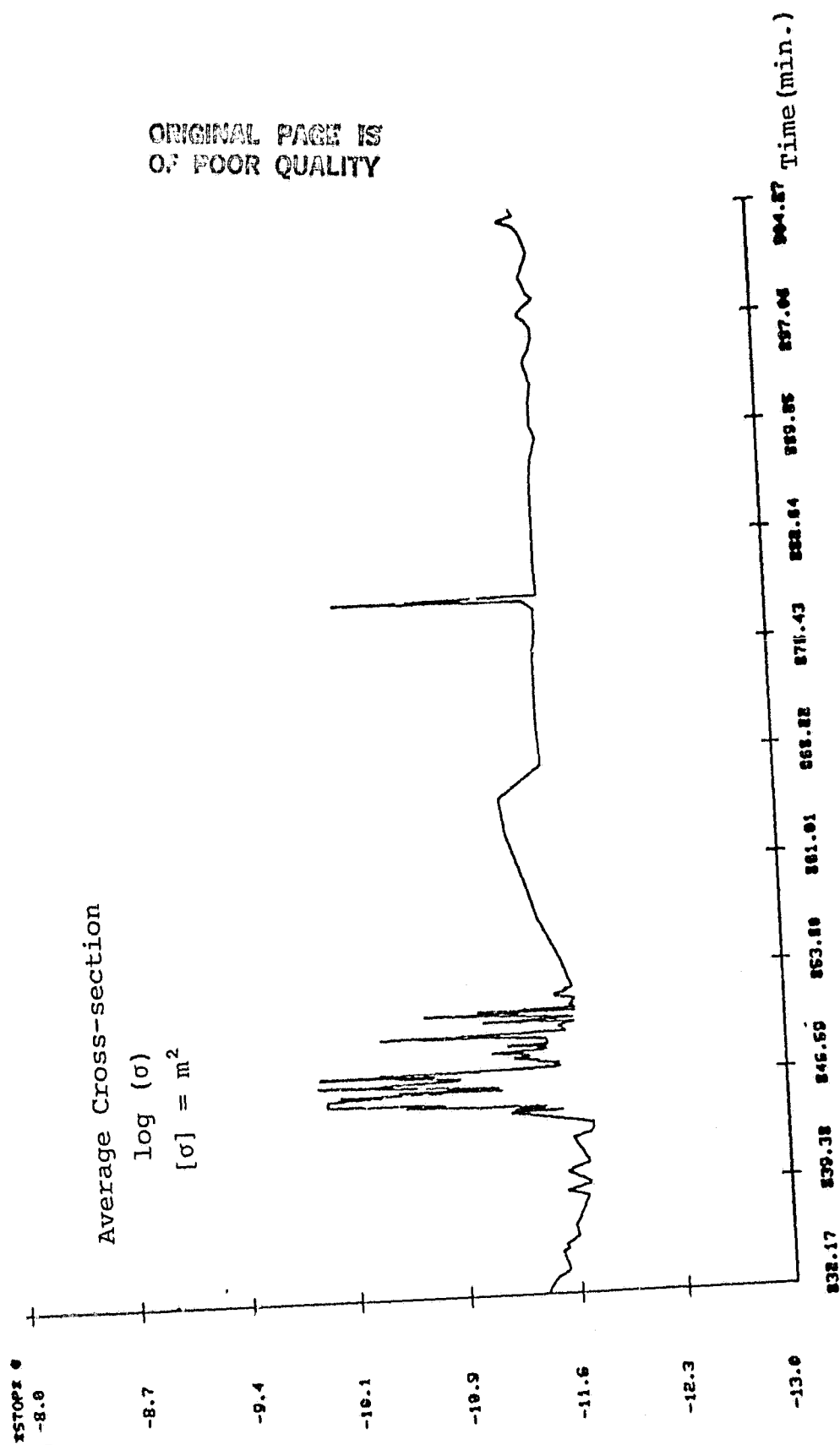


Fig. 42 Average Cross-section σ

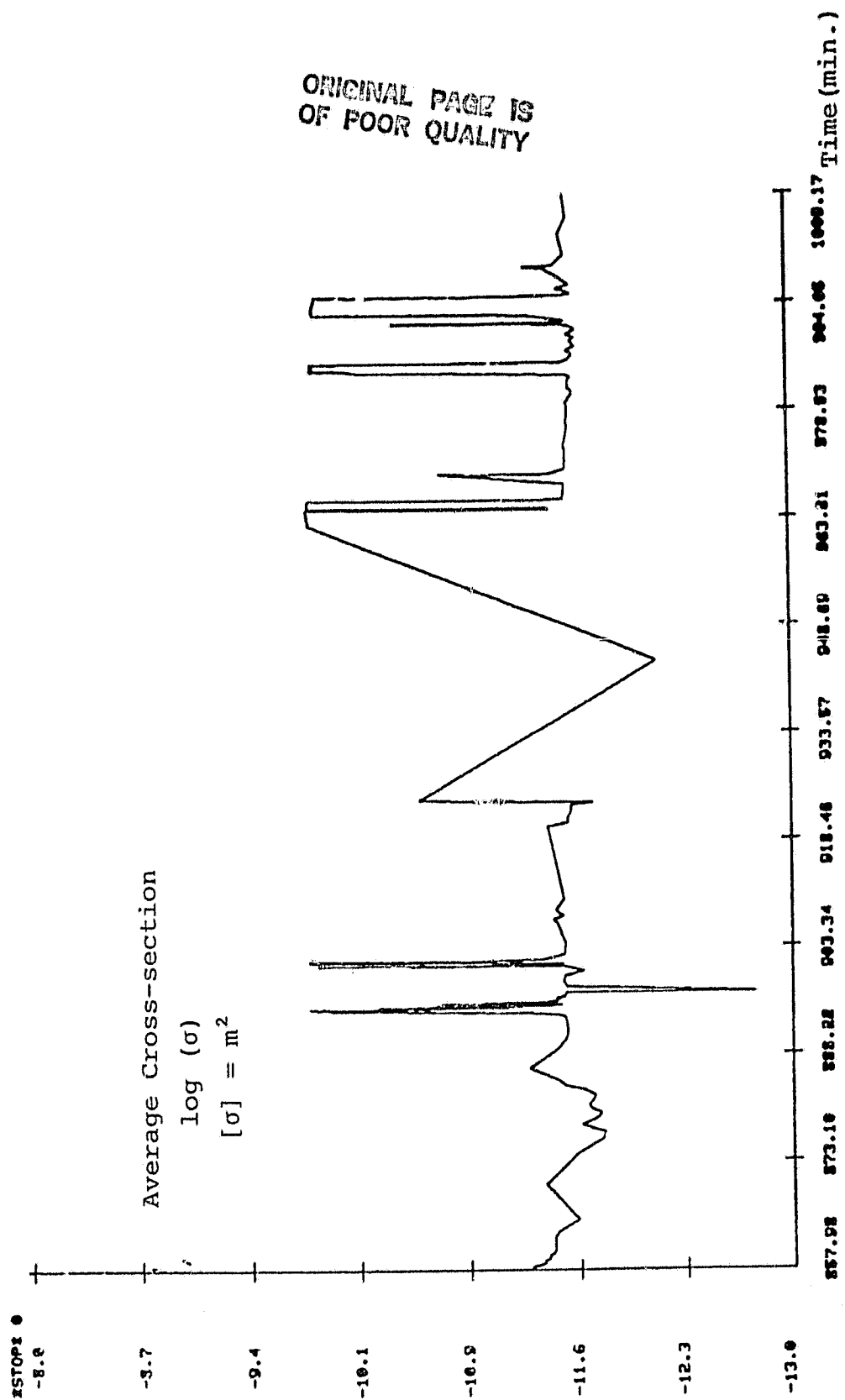


Fig. 43 Average Cross-section σ

NUMBER 18 18

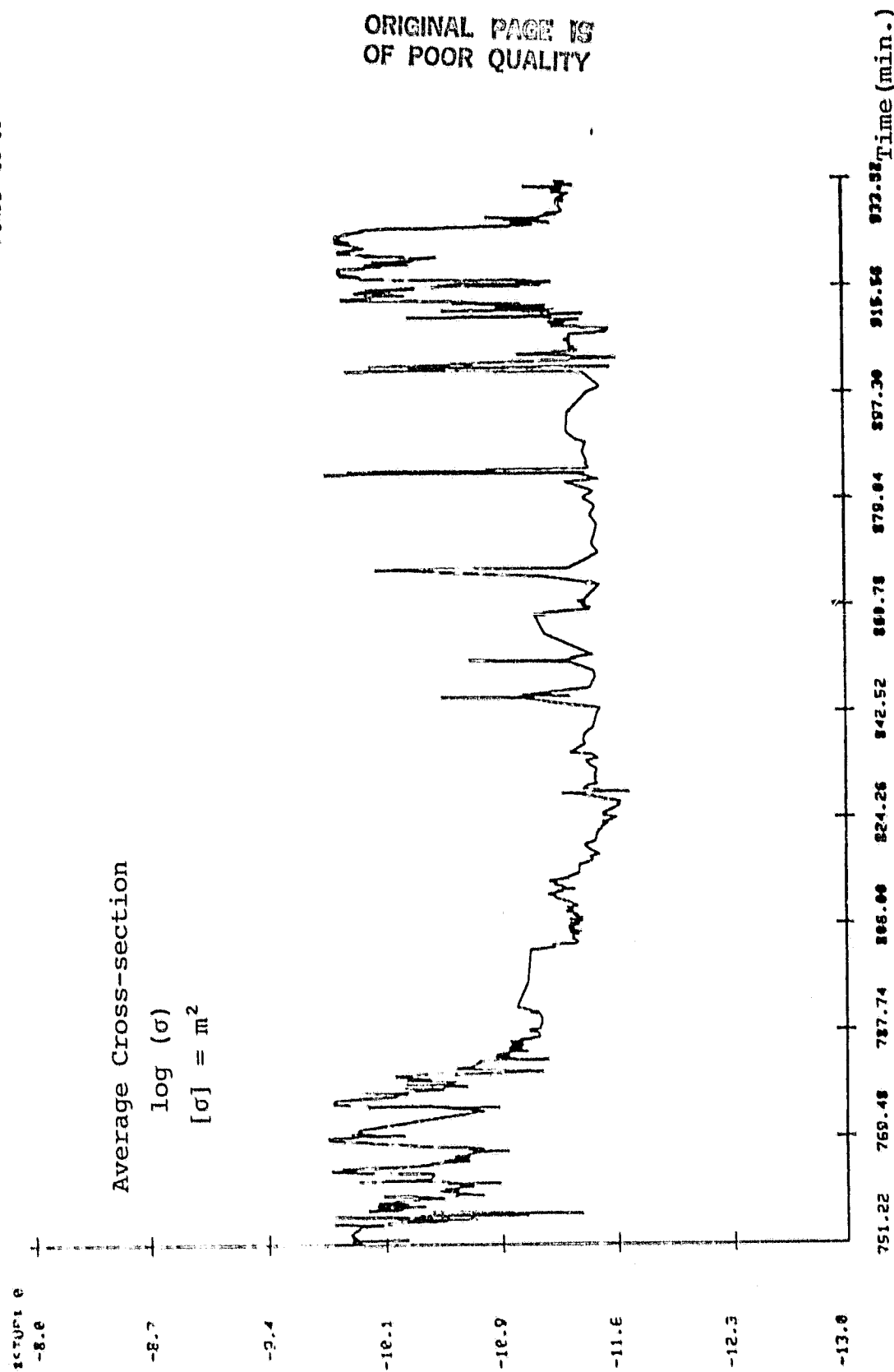


Fig. 44 Average Cross-section σ

NUMBER IS 19

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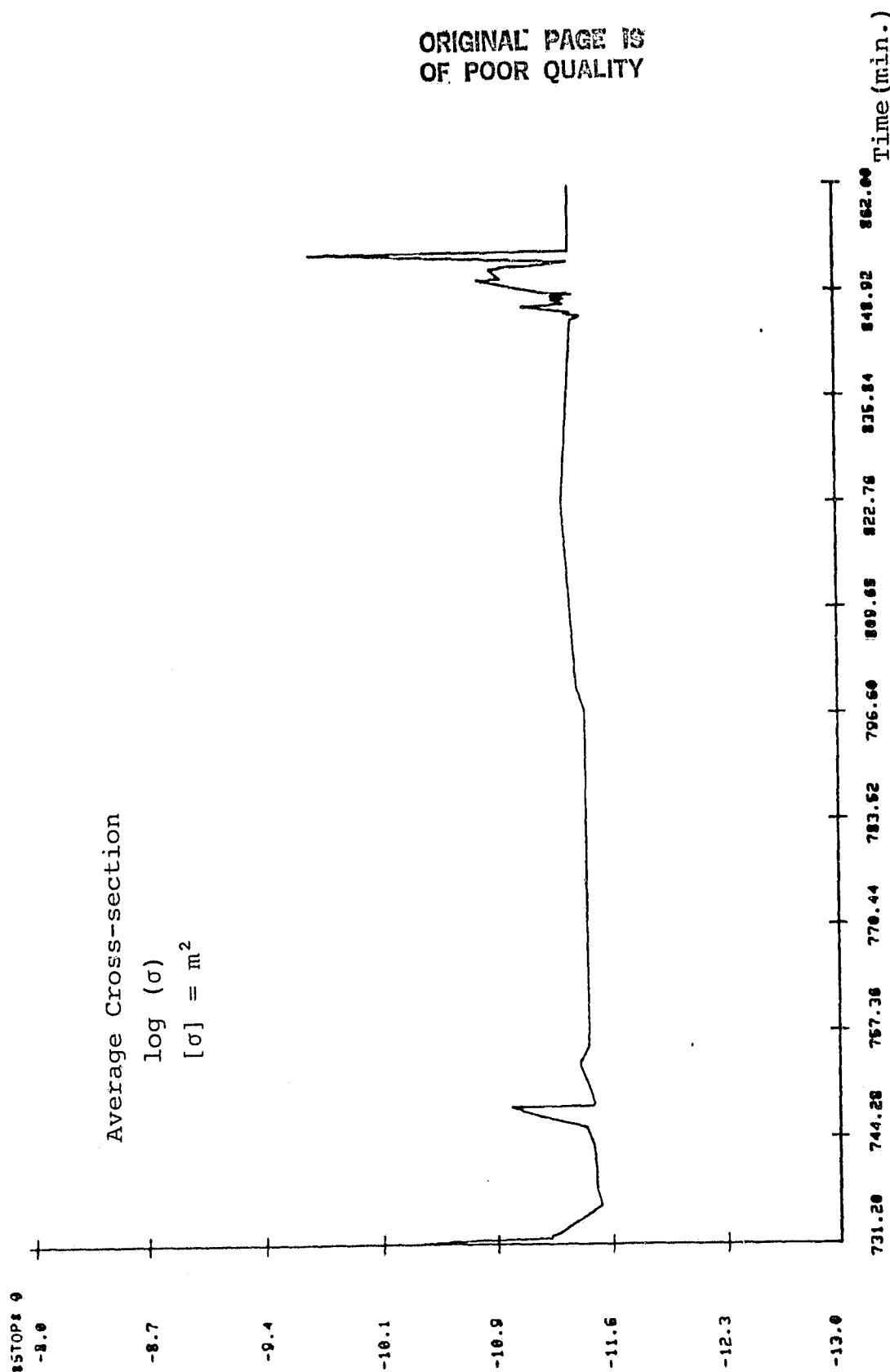


Fig. 45 Average Cross-section σ

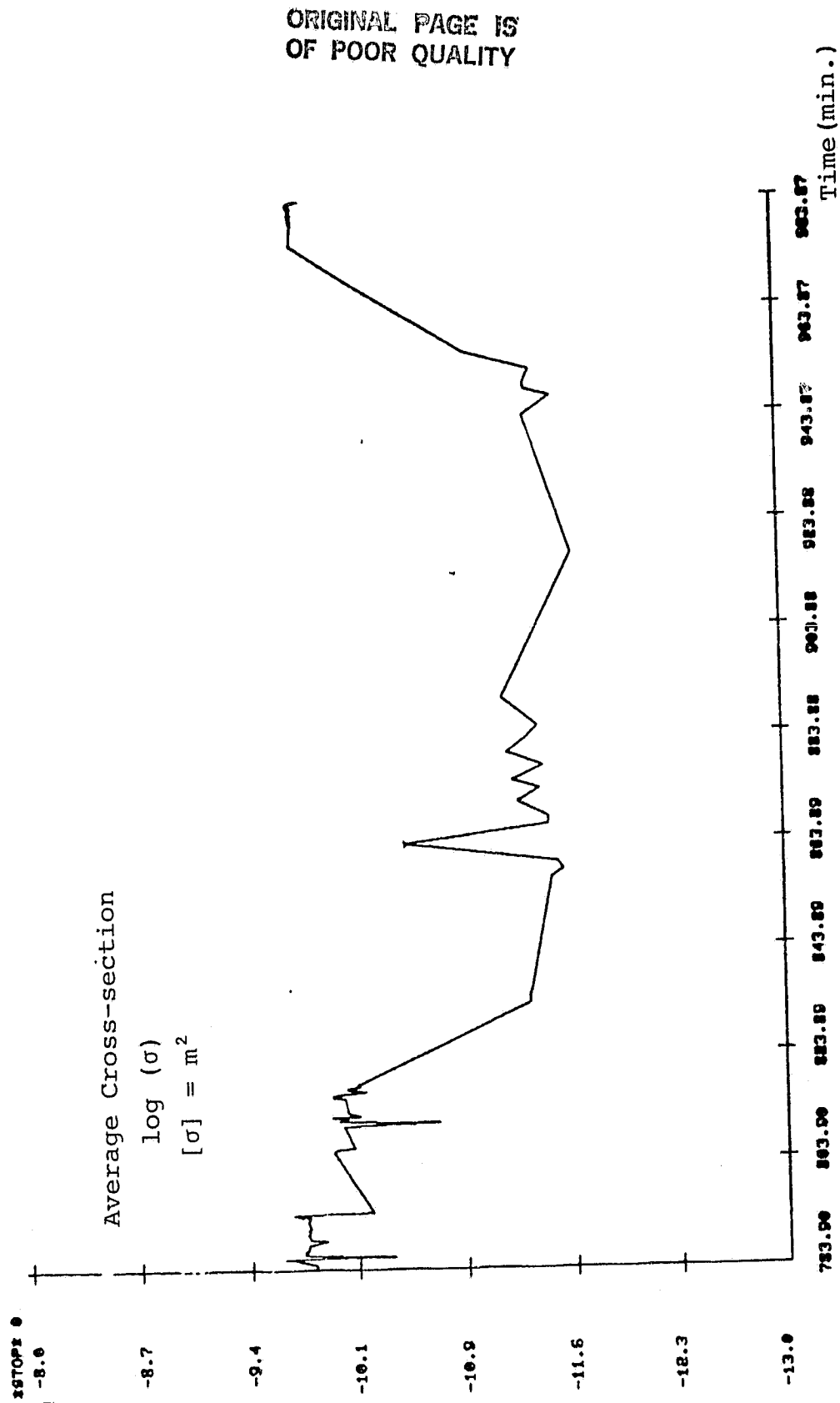


Fig. 46 Average Cross-section σ

NUMBER 15 21

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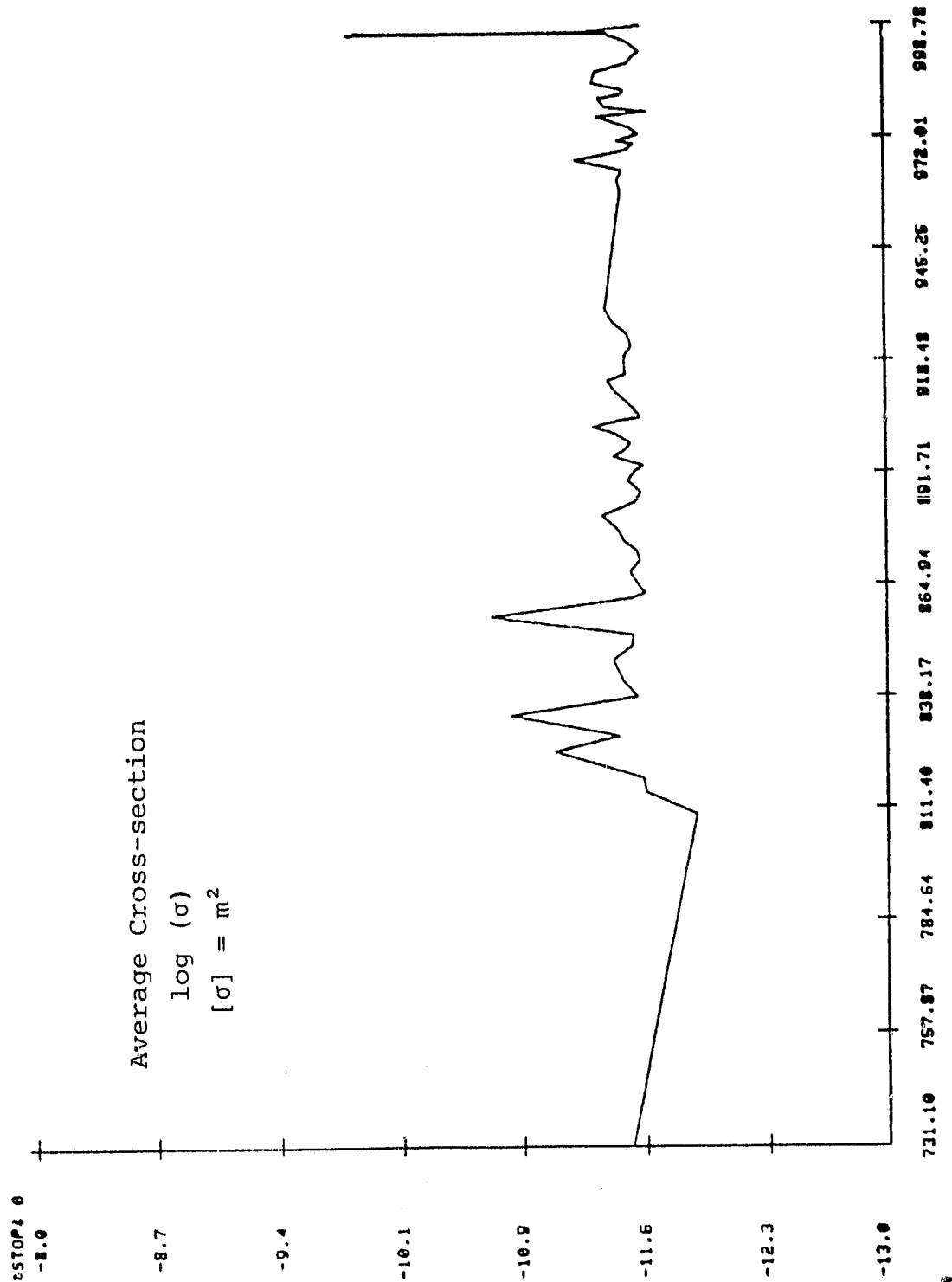


Fig. 47 Average Cross-section σ

NUMBER 15 22

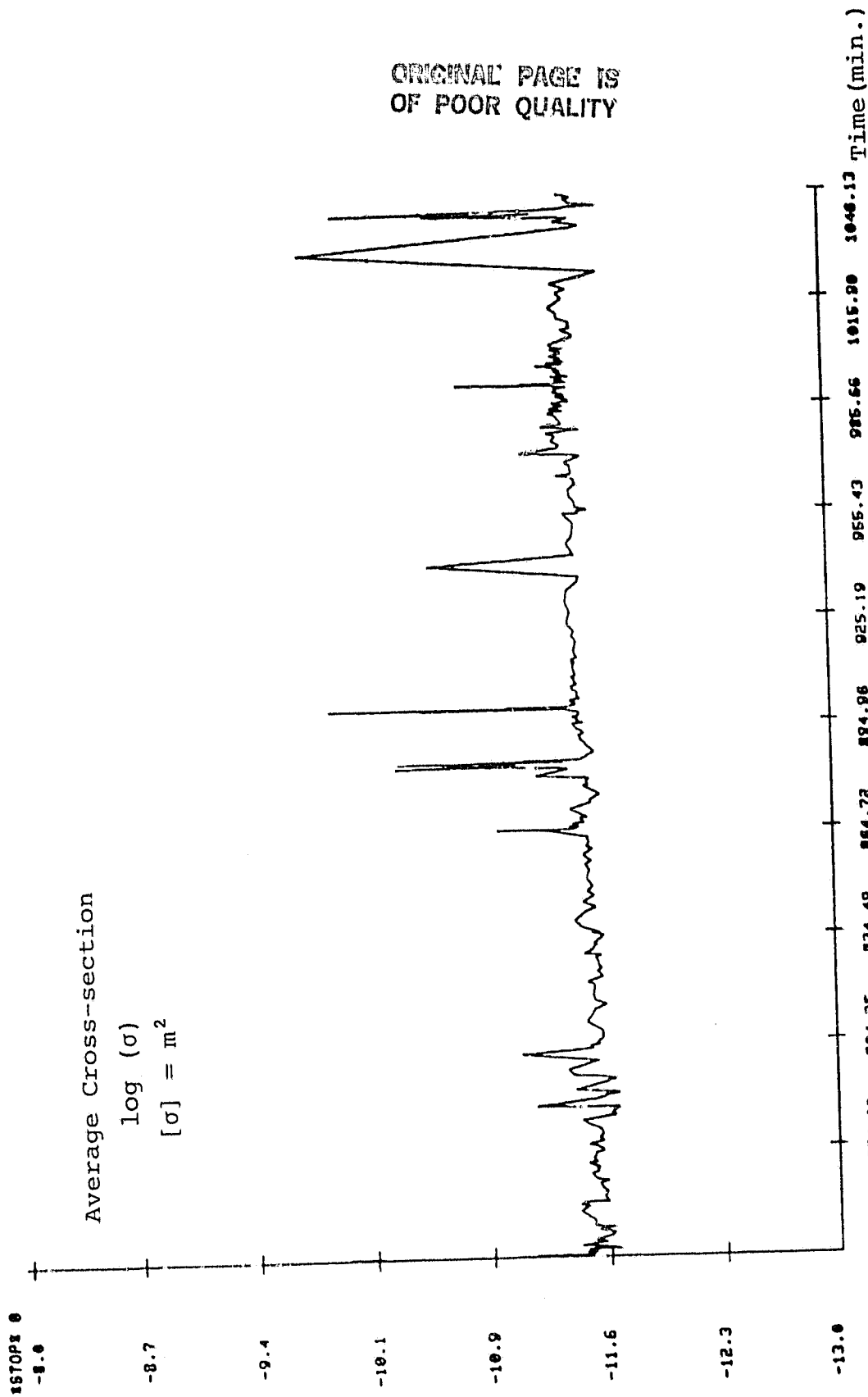


Fig. 48 Average Cross-section σ

NUMBER IS 23

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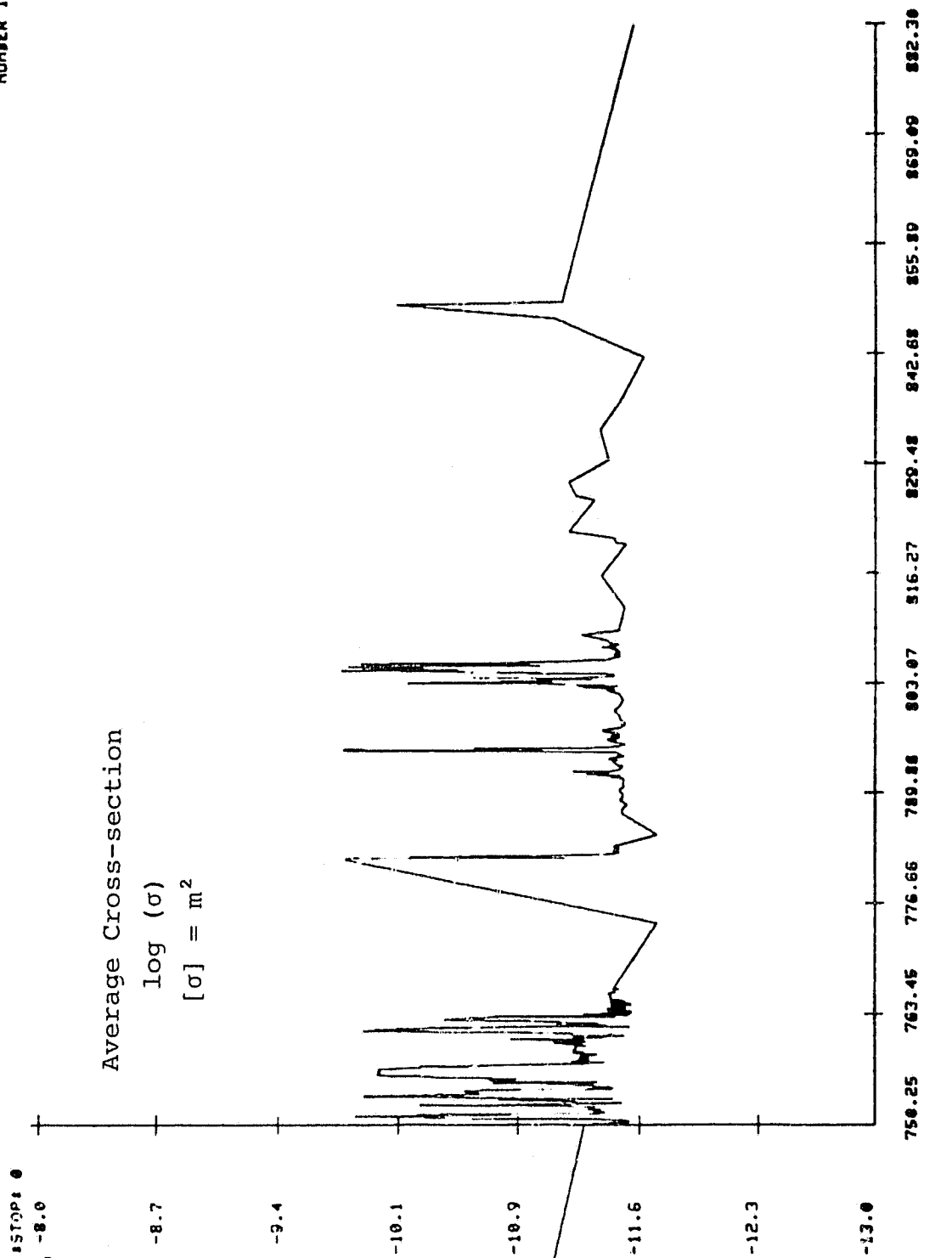


Fig. 49 Average Cross-section σ

NUMBER IS 1

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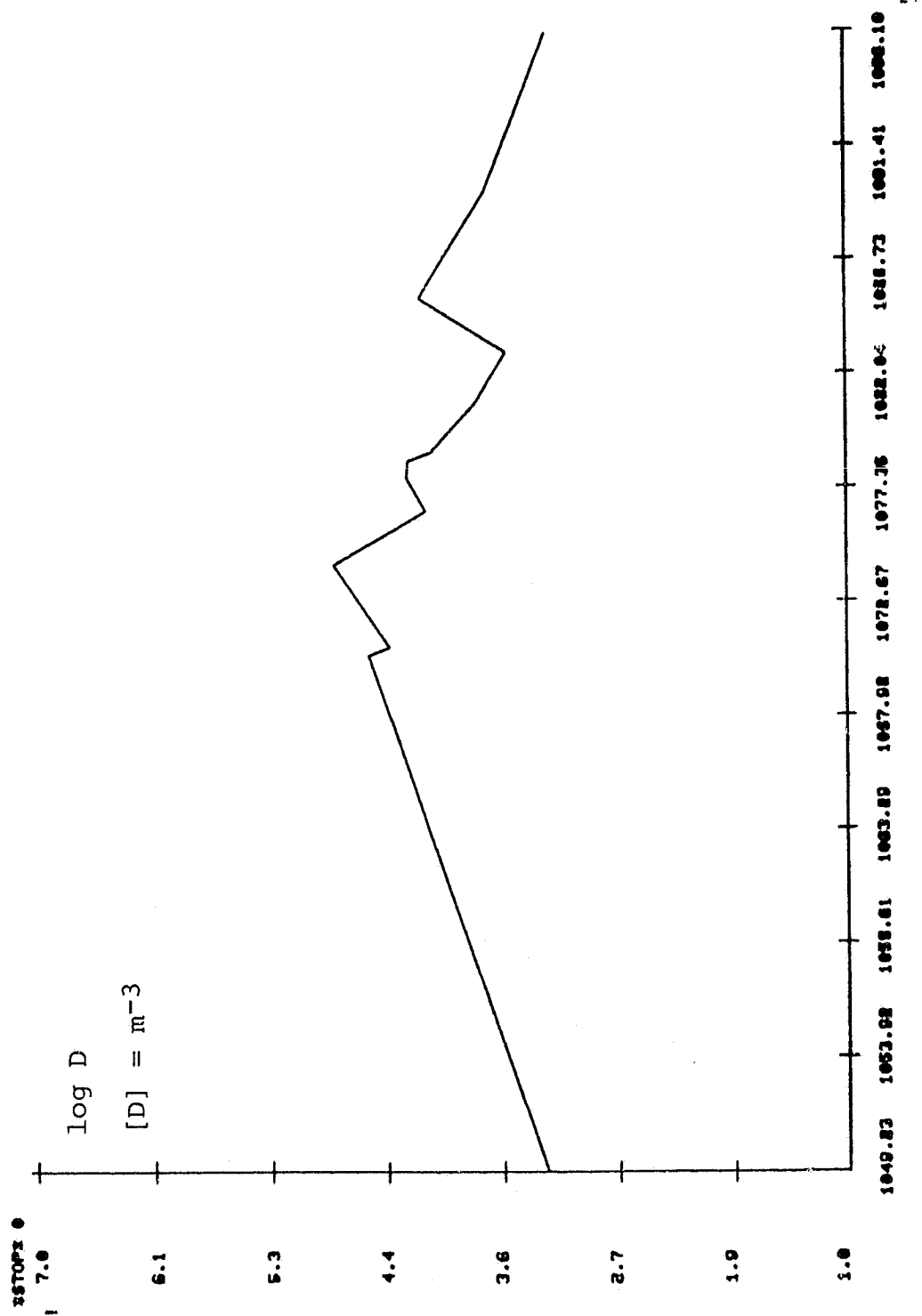


Fig. 50 Particle Density D

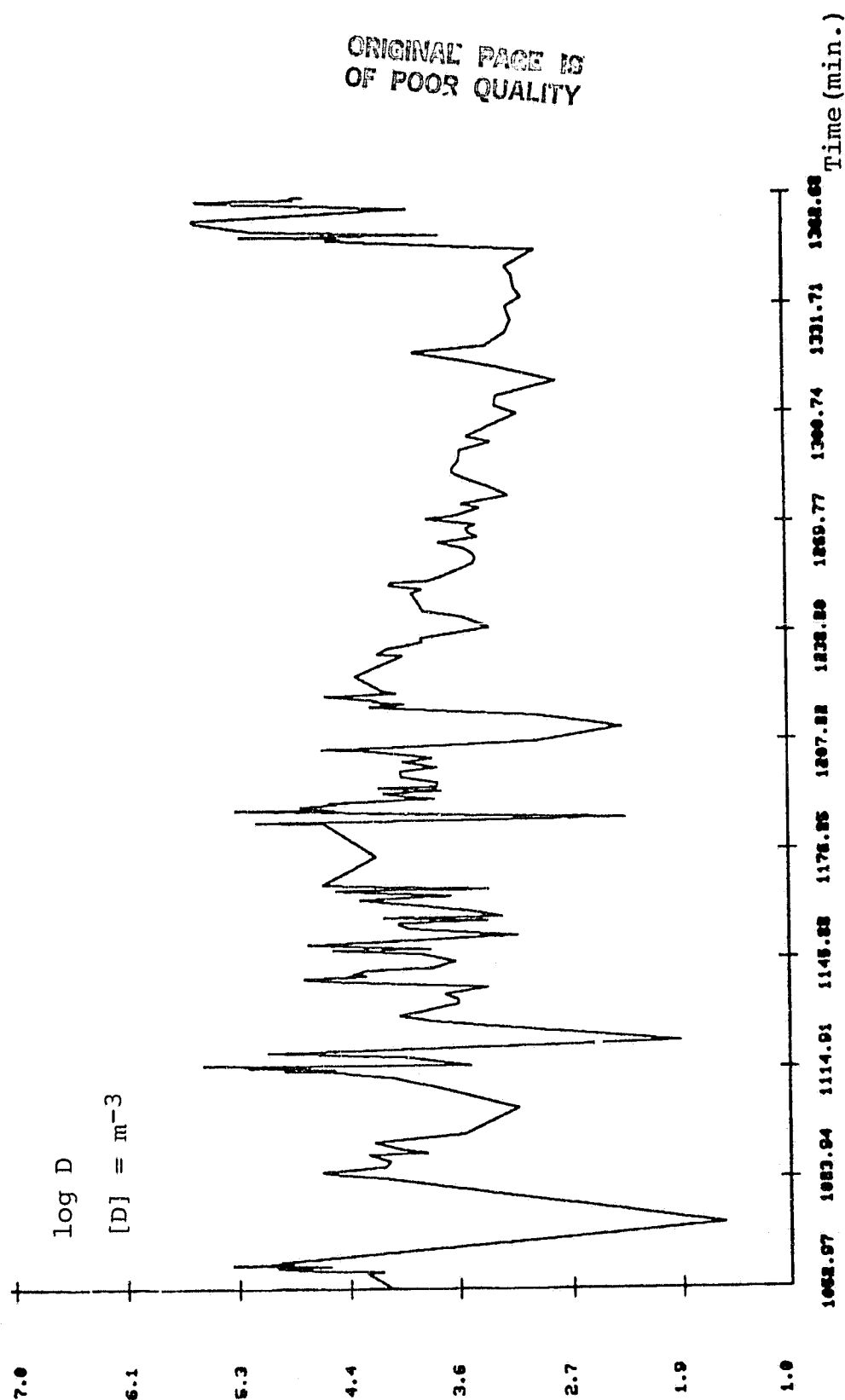


Fig. 51 Particle Density D

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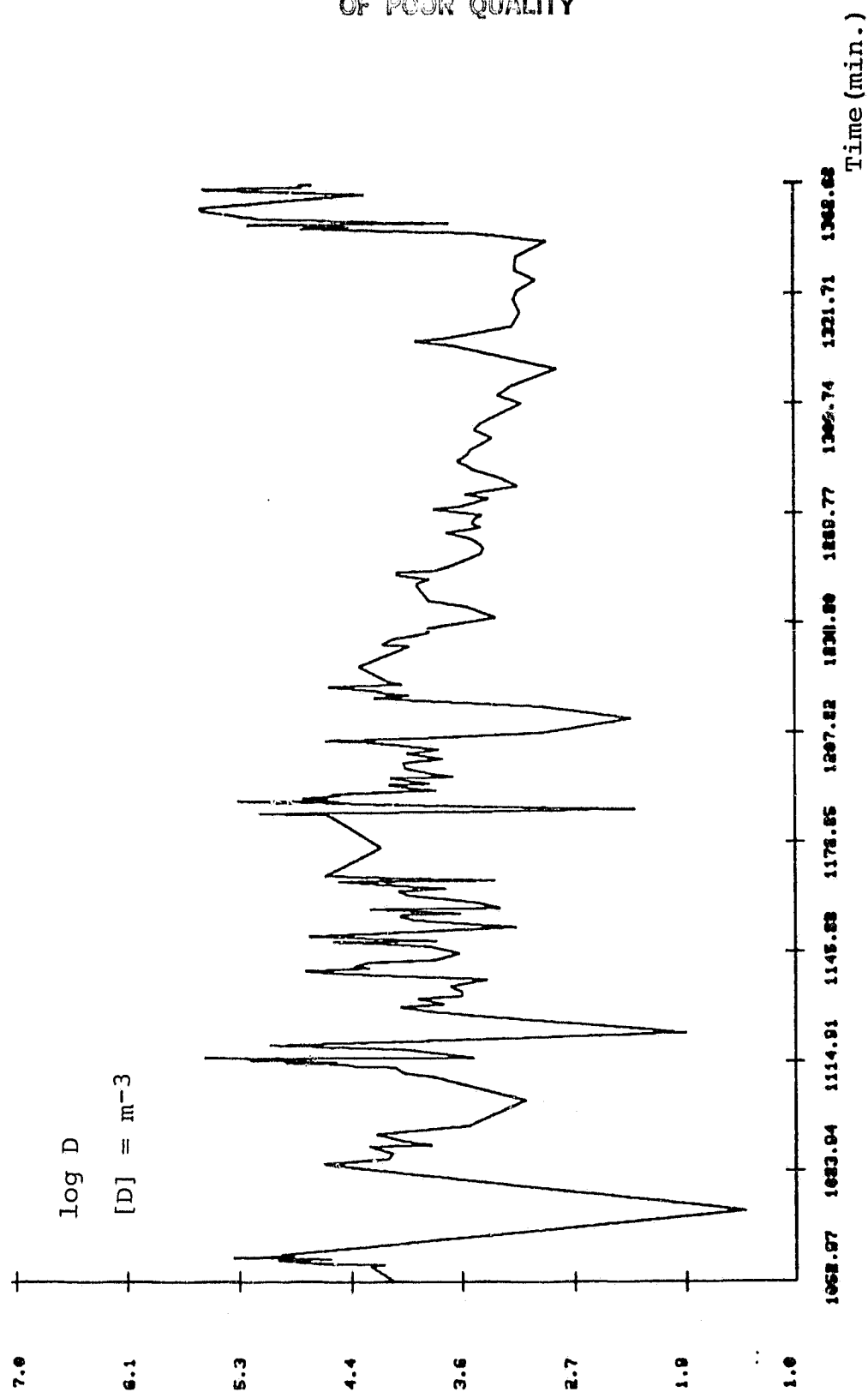


Fig. 52 Particle Density D

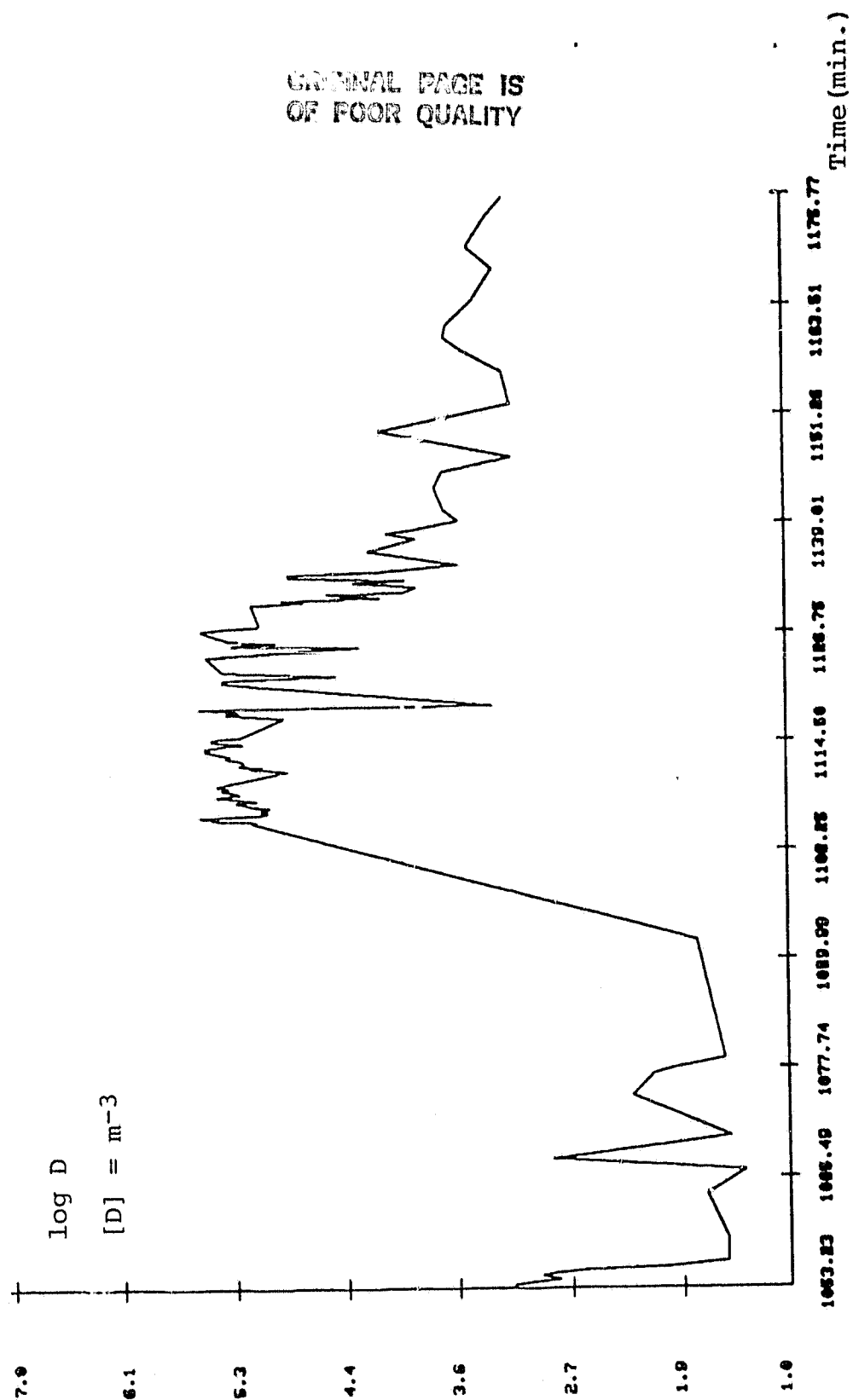


Fig. 53 Particle Density D

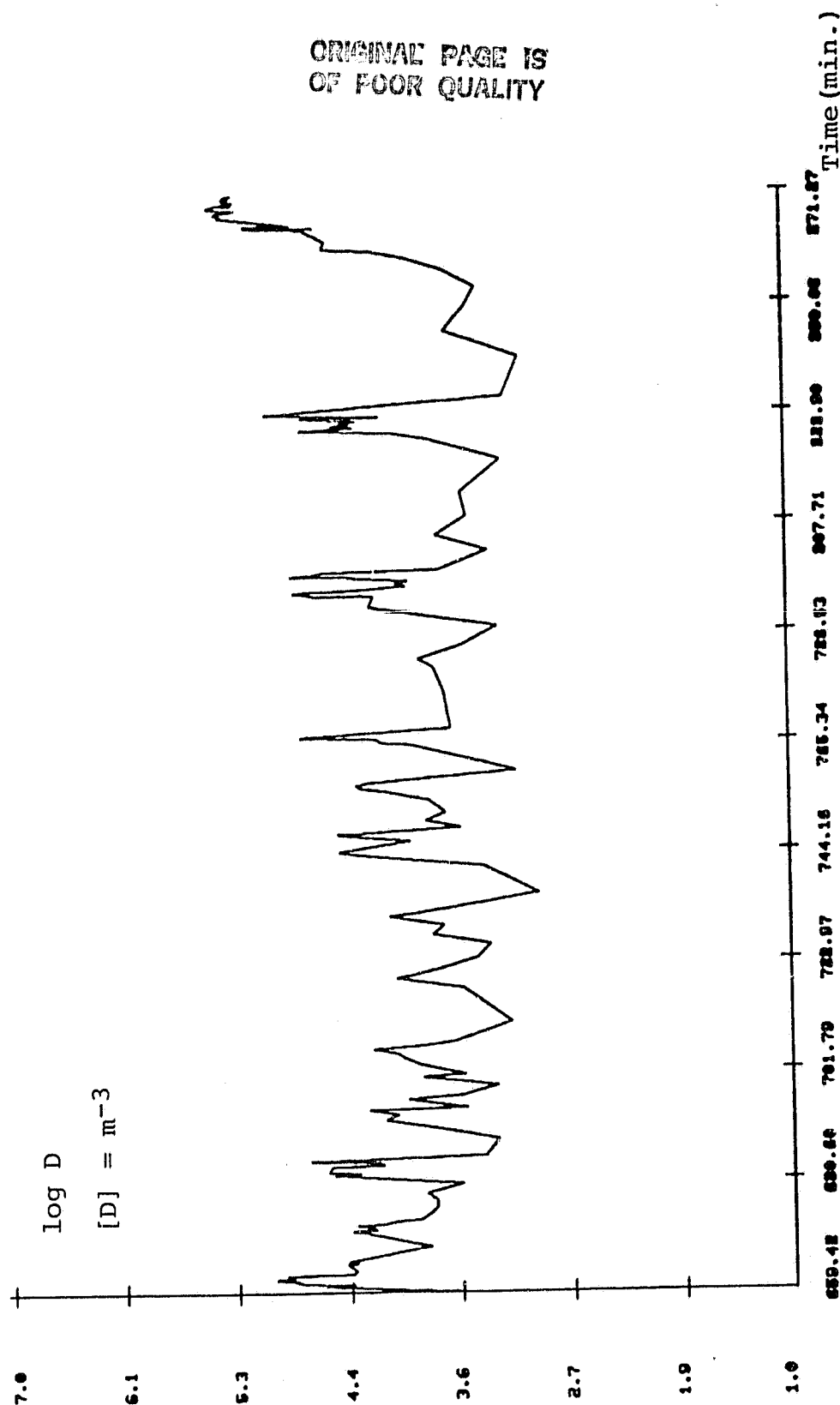
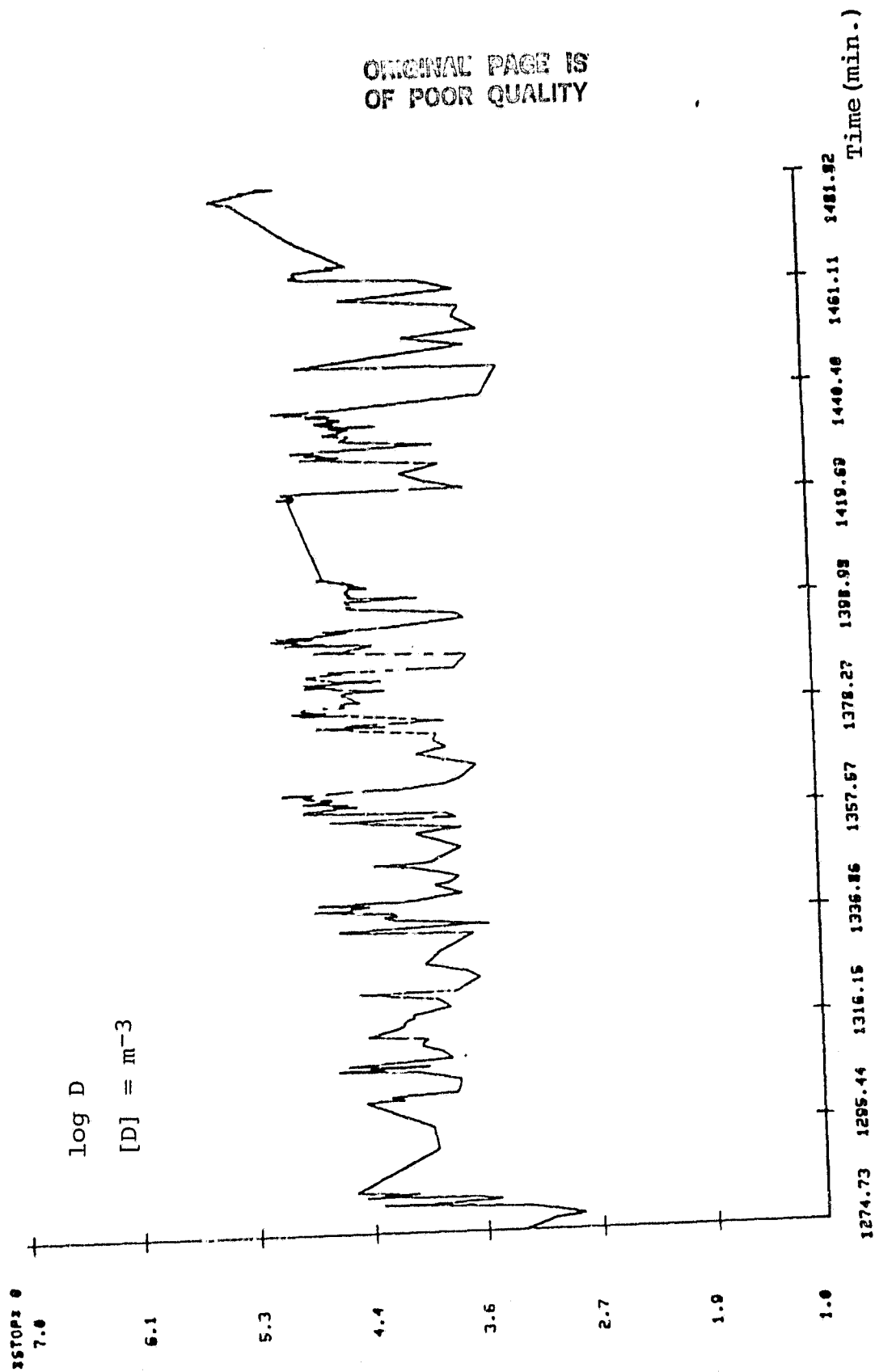


Fig. 54 Particle Density D

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Particle Density D

Fig. 55

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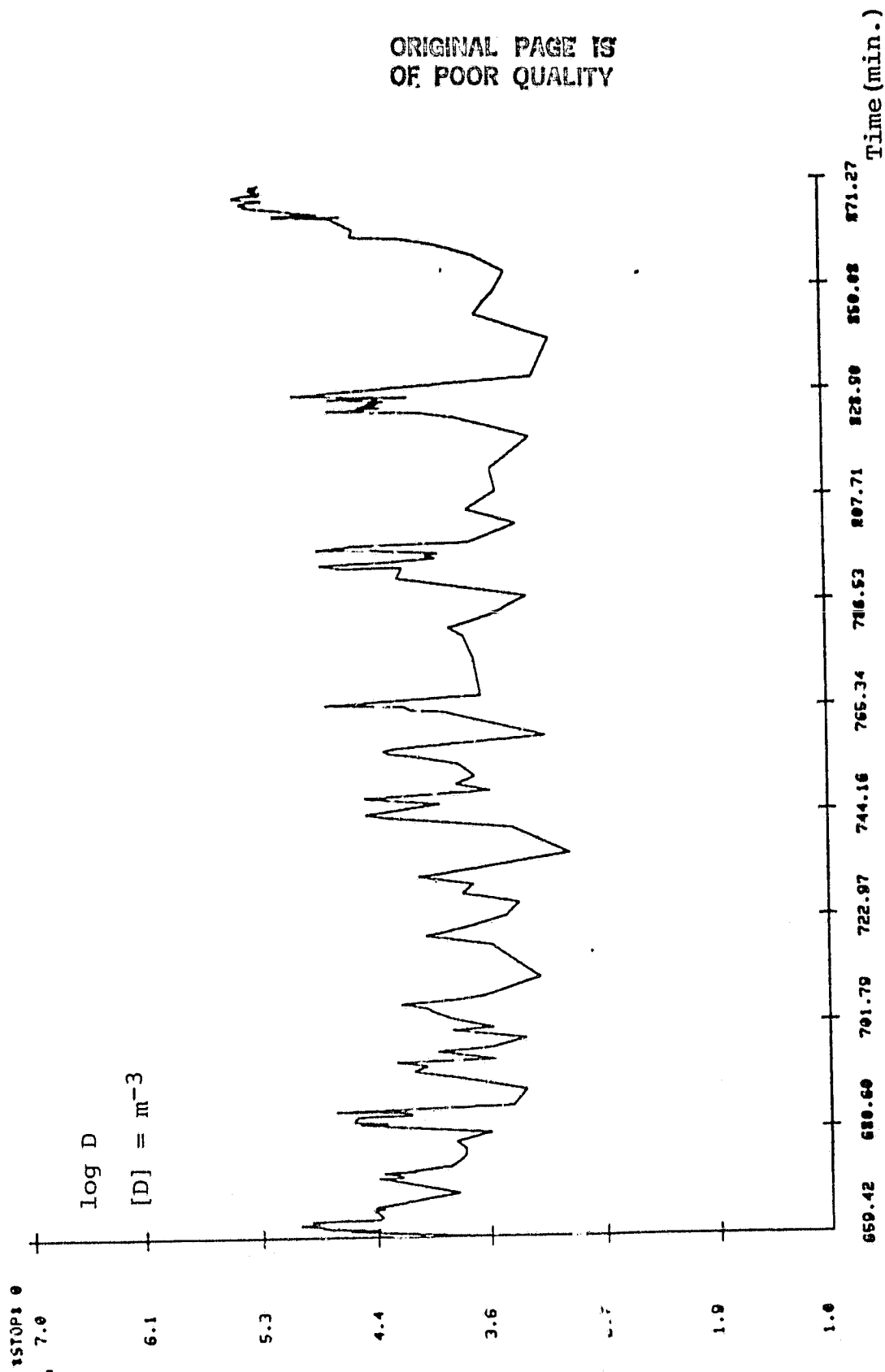


Fig. 56 Particle Density D

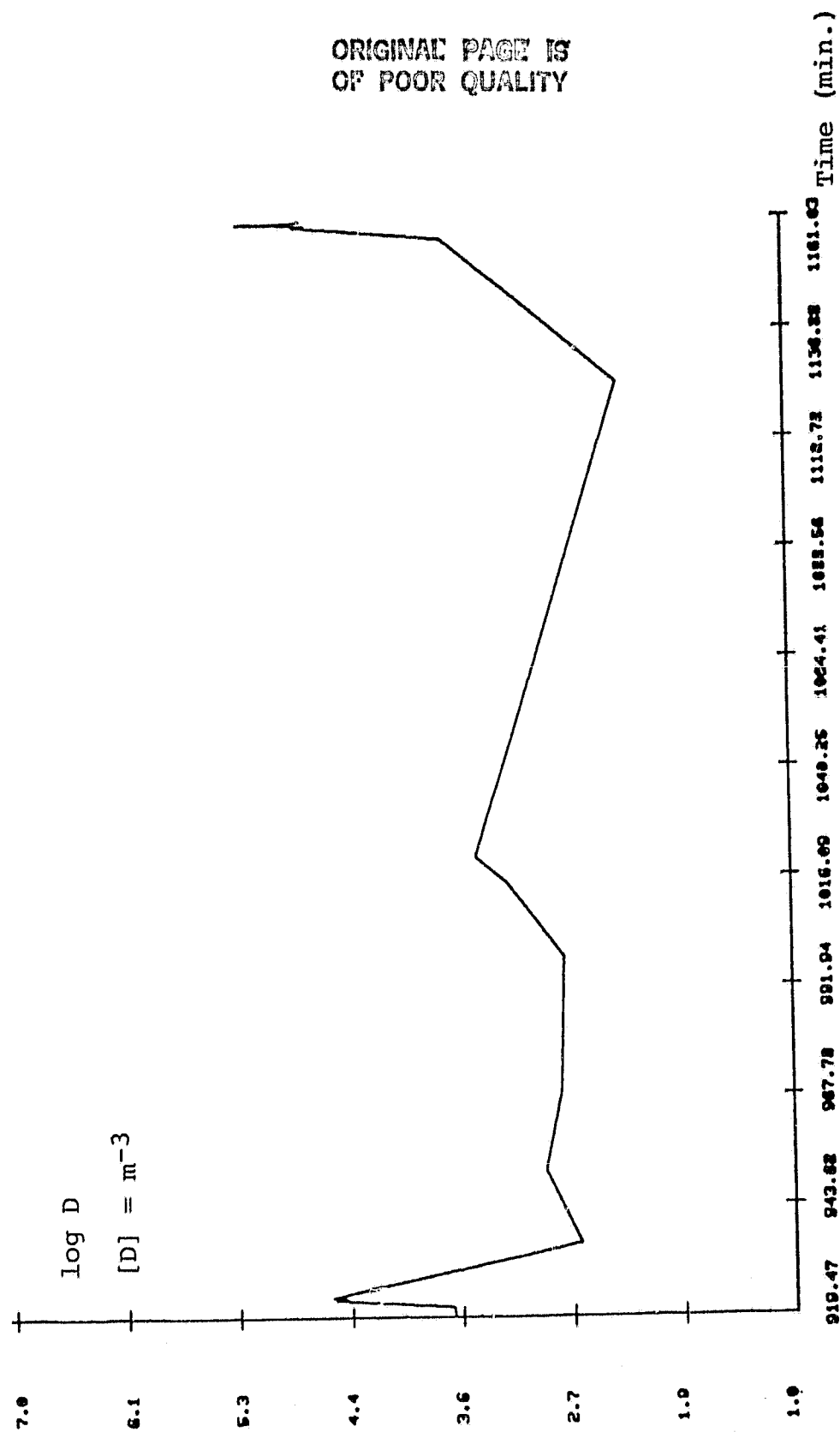


Fig. 57 Particle Density D

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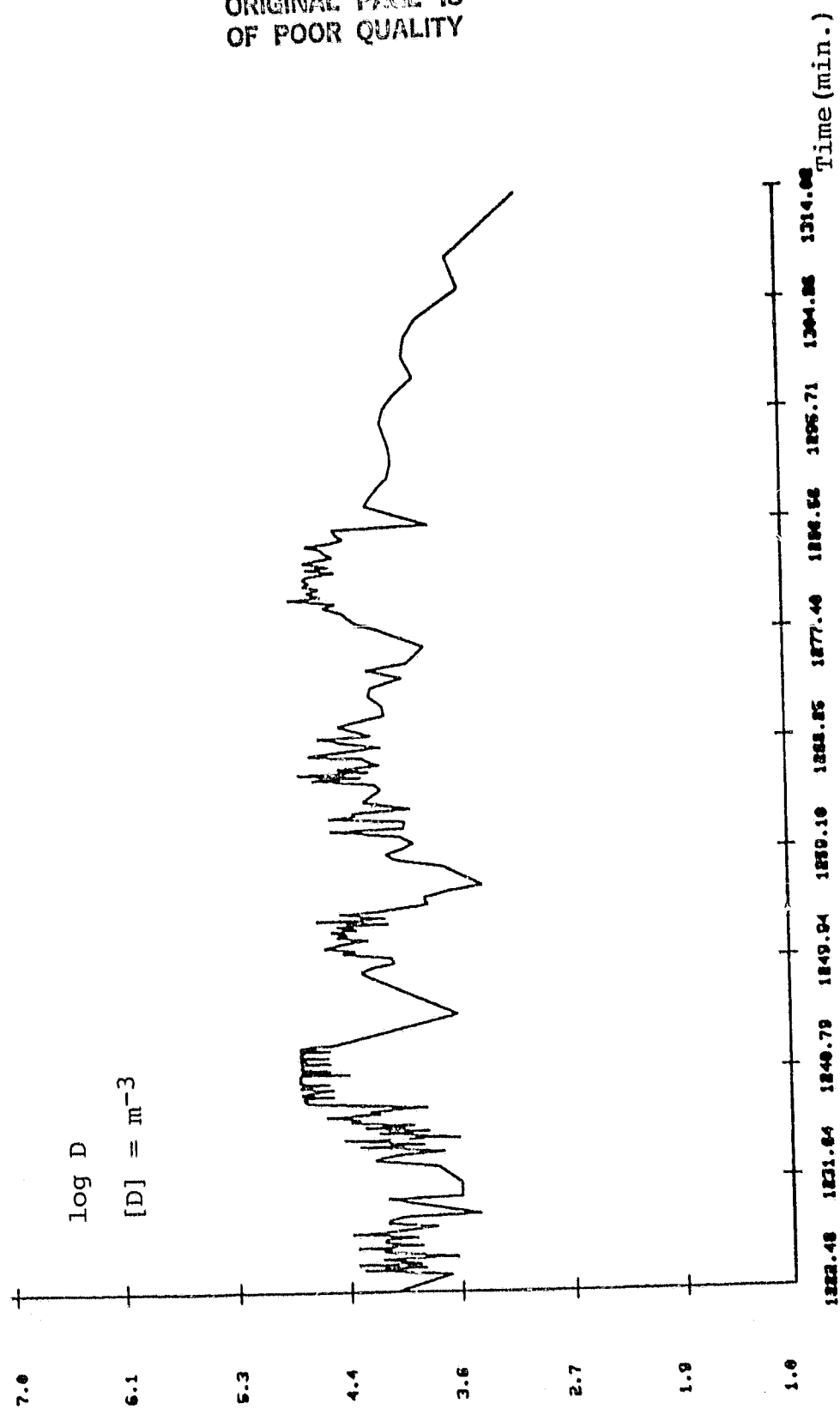


Fig. 58 Particle Density D

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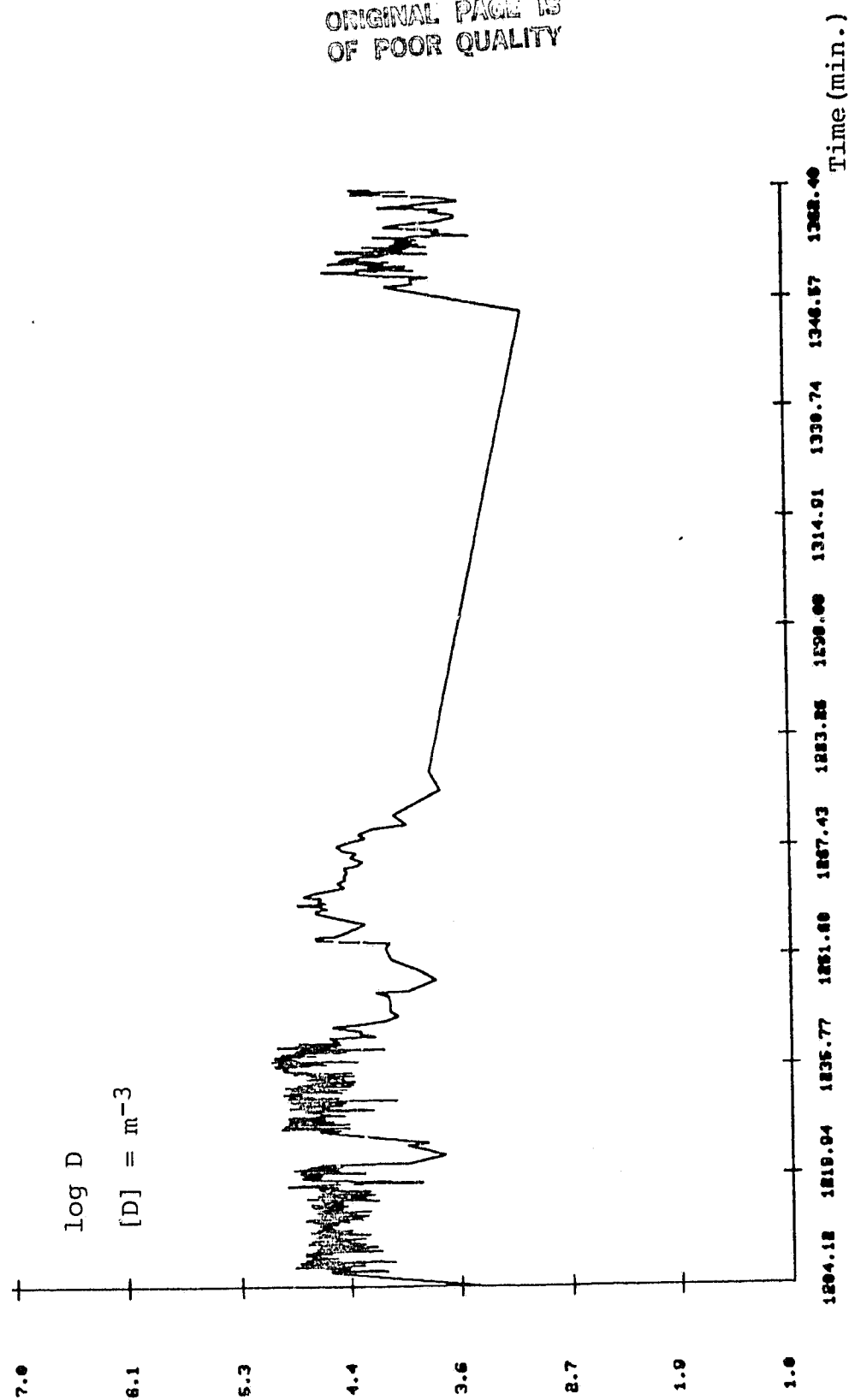


Fig. 59 Particle Density D

NUMBER IS 11

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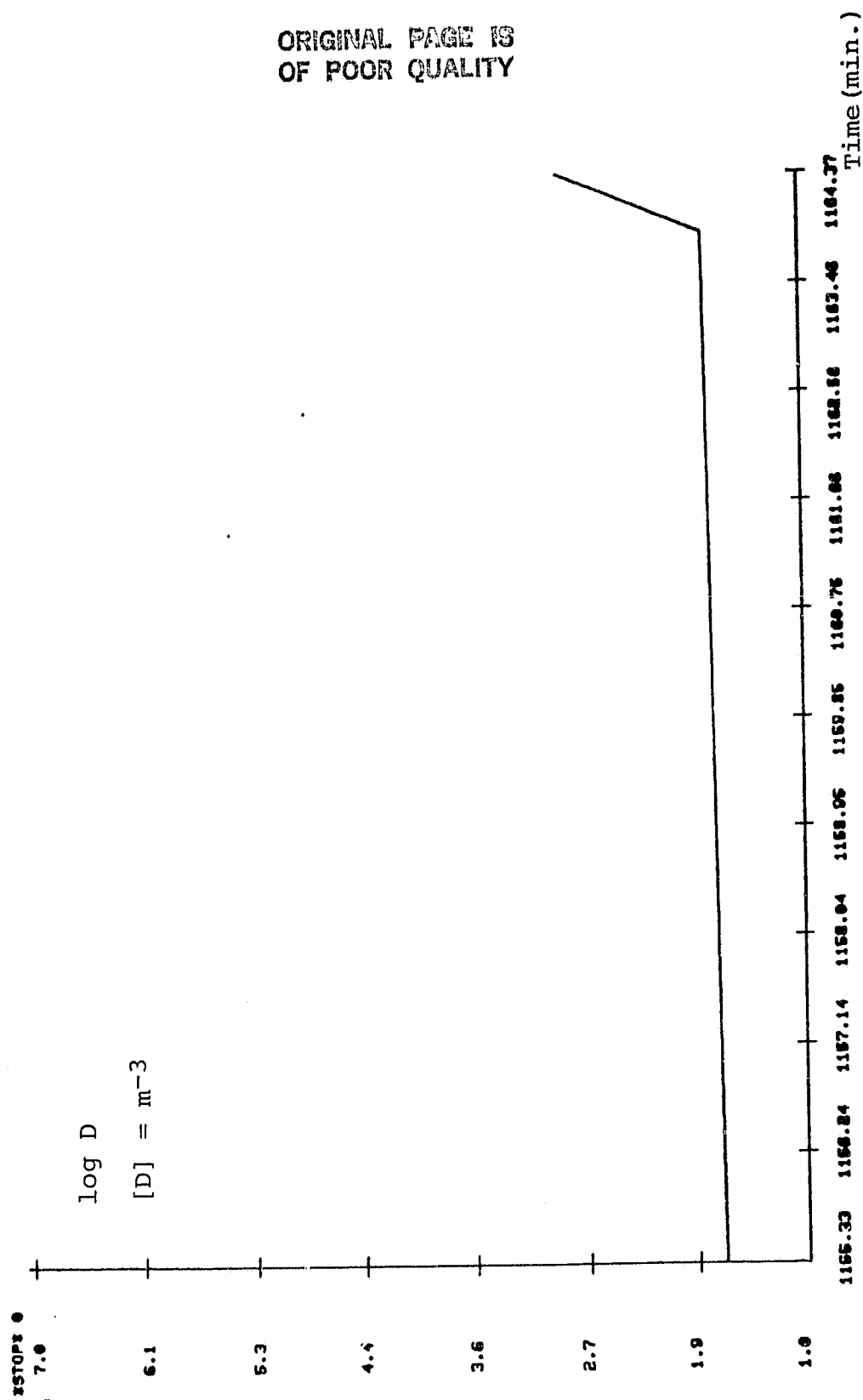
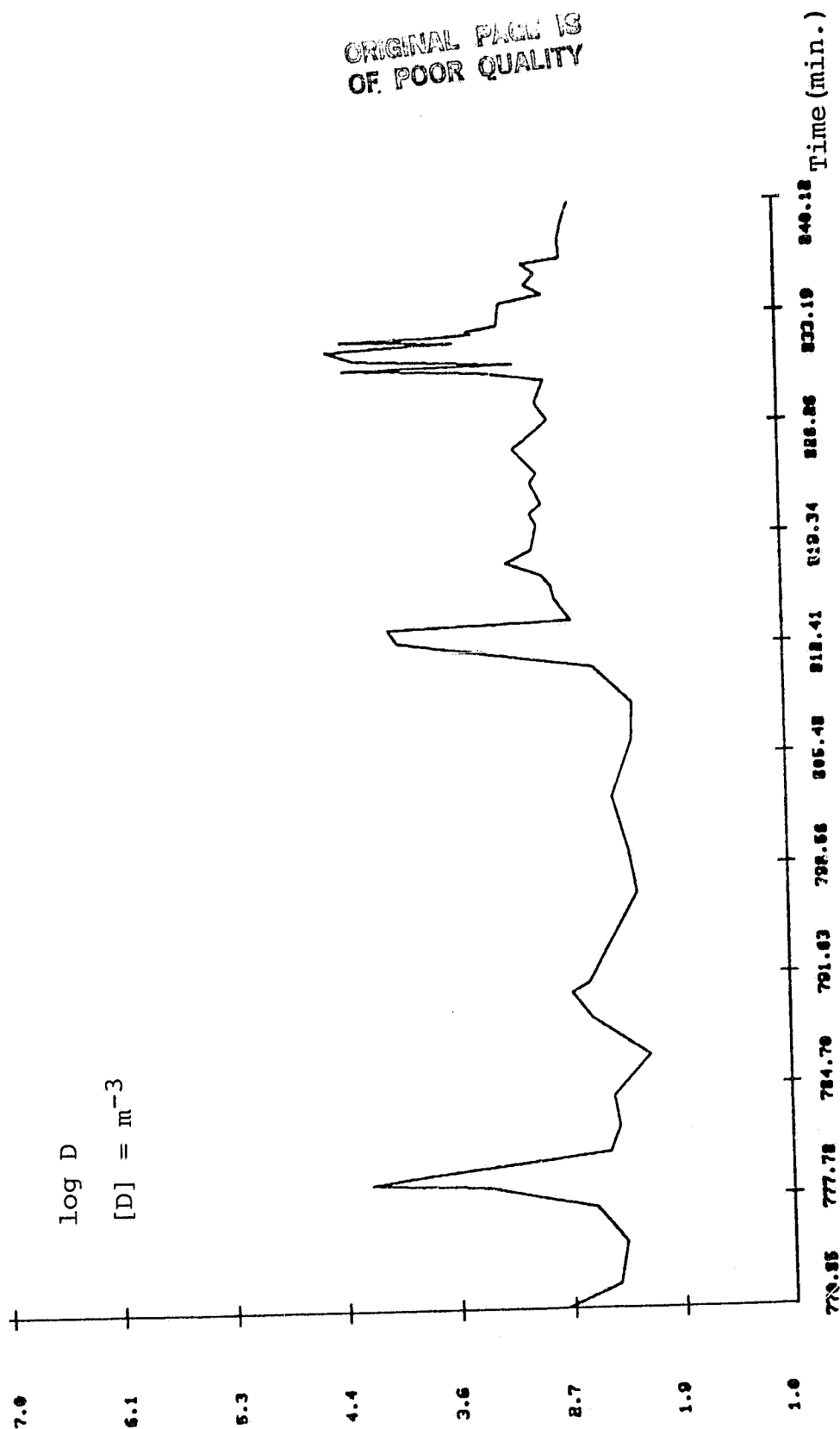


Fig. 60 Particle Density D



Particle Density D

Fig. 61

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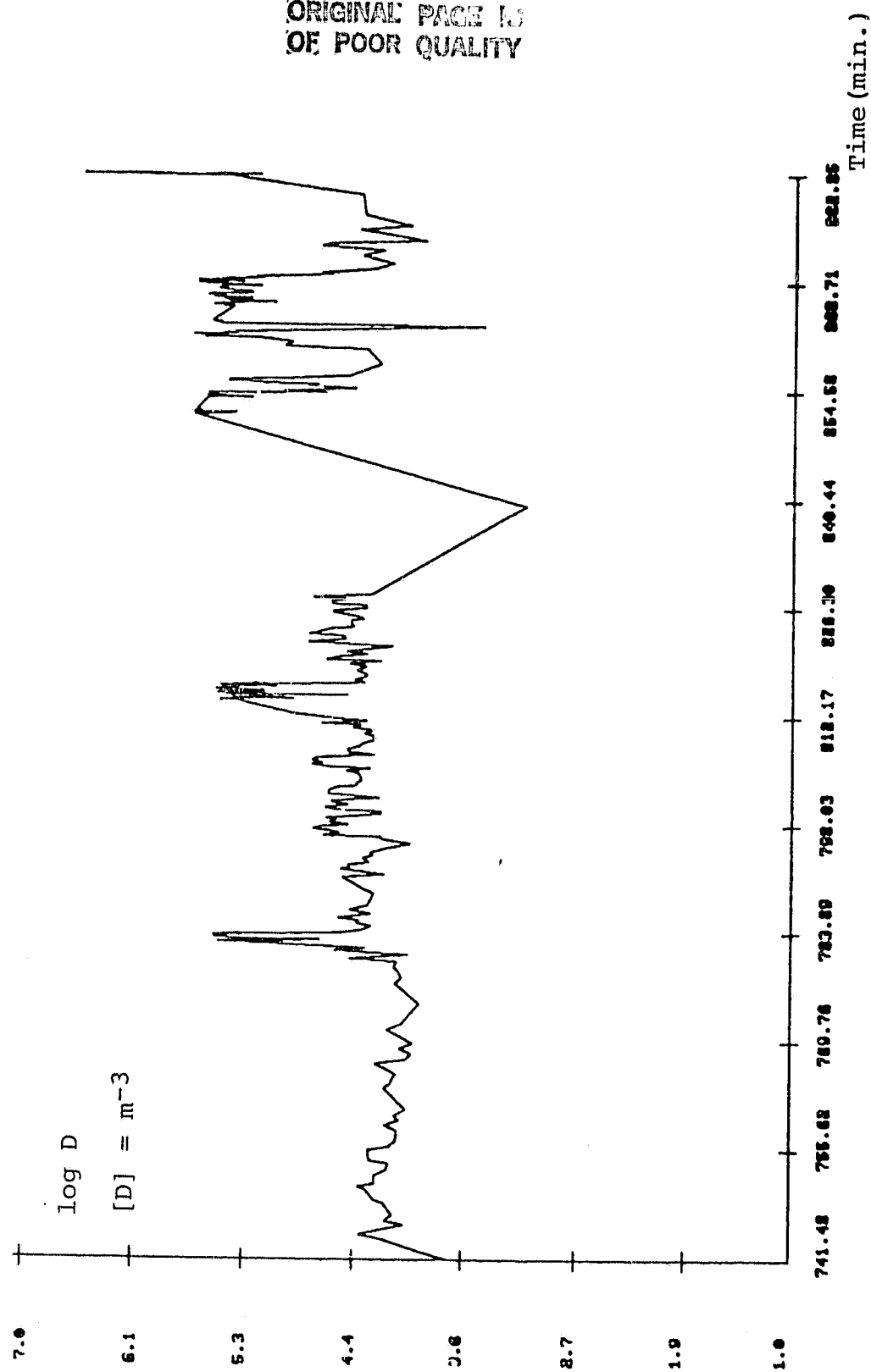


Fig. 62 Particle Density D

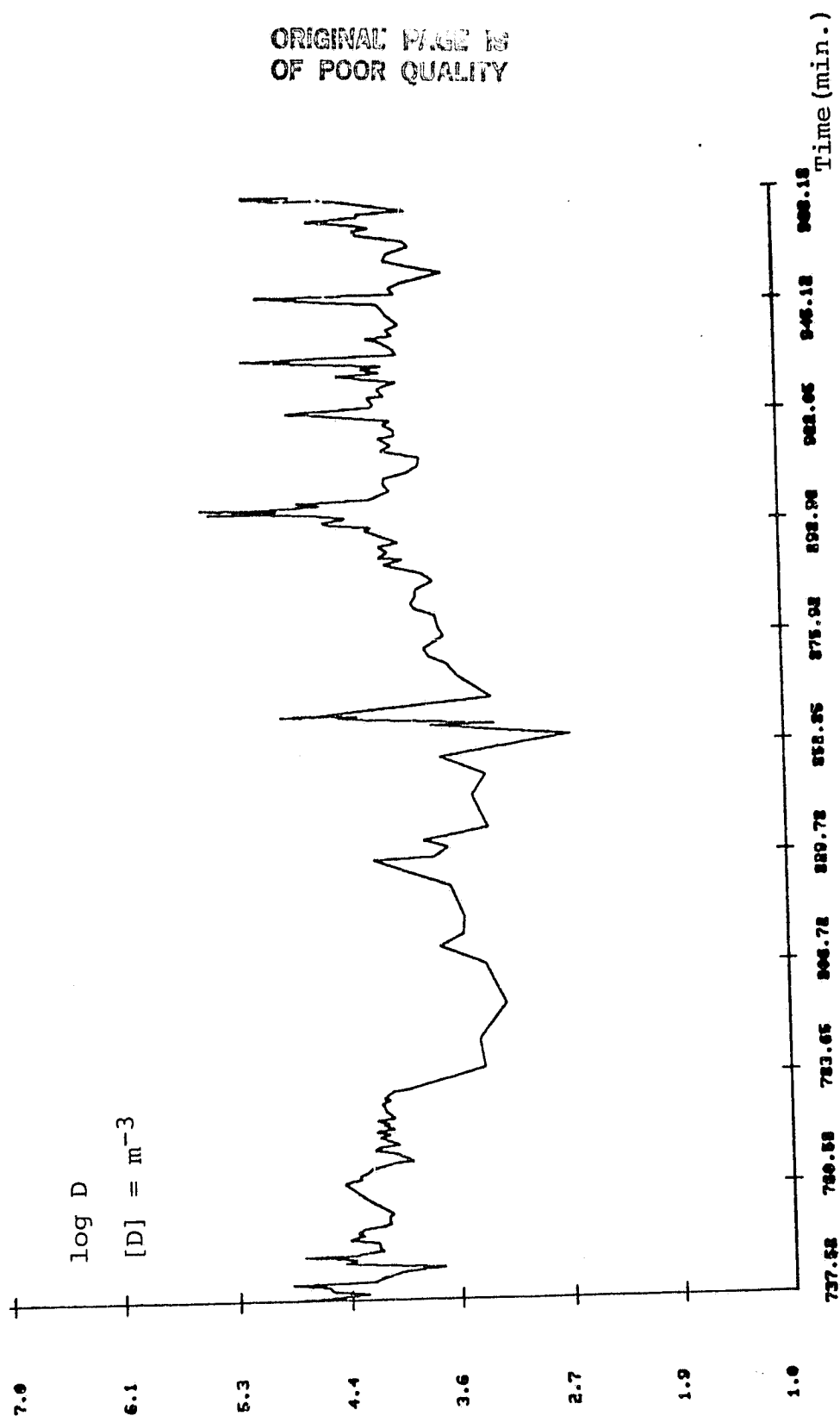


Fig. 63 Particle Density D

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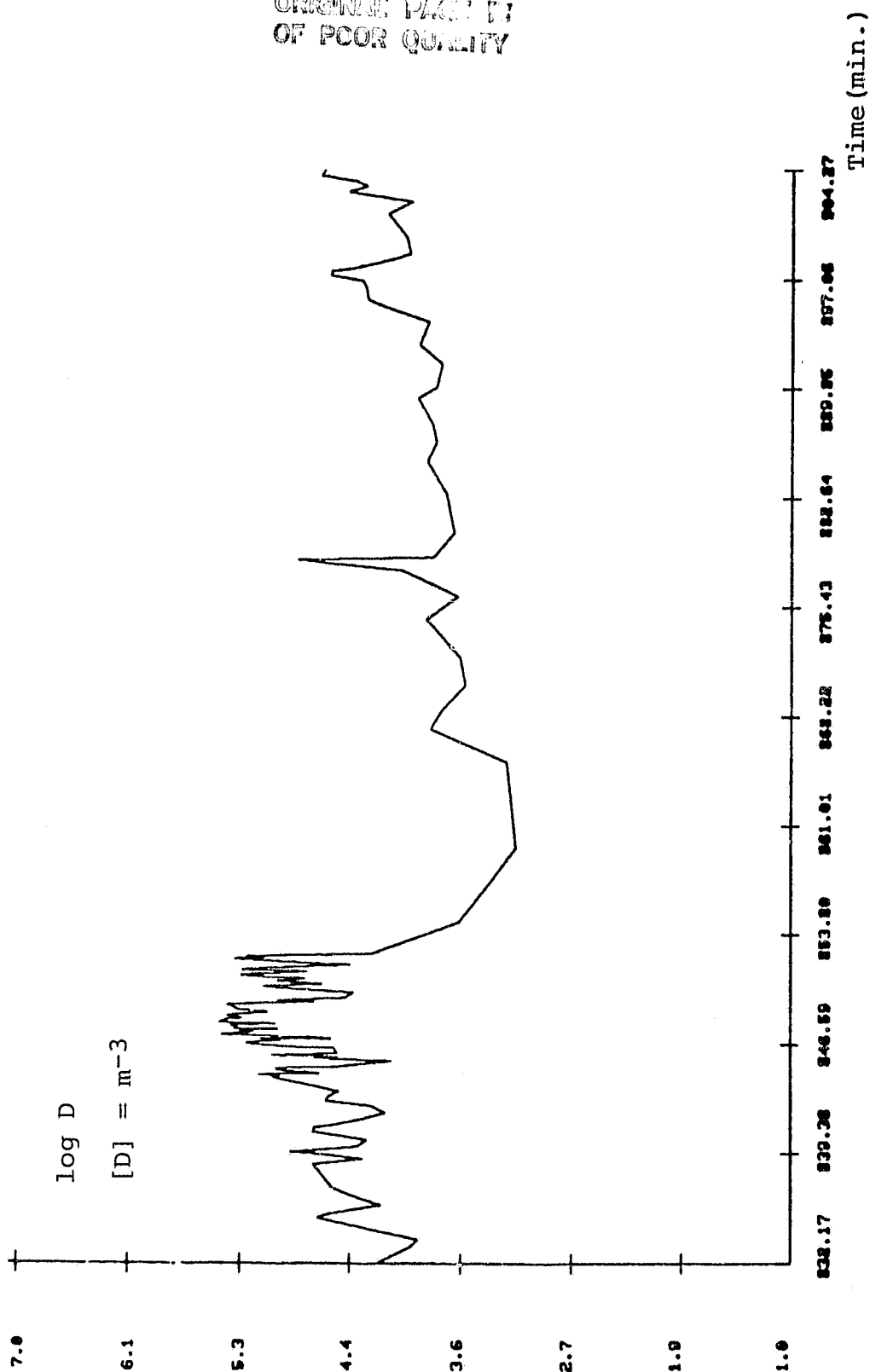


Fig. 64 Particle Density D

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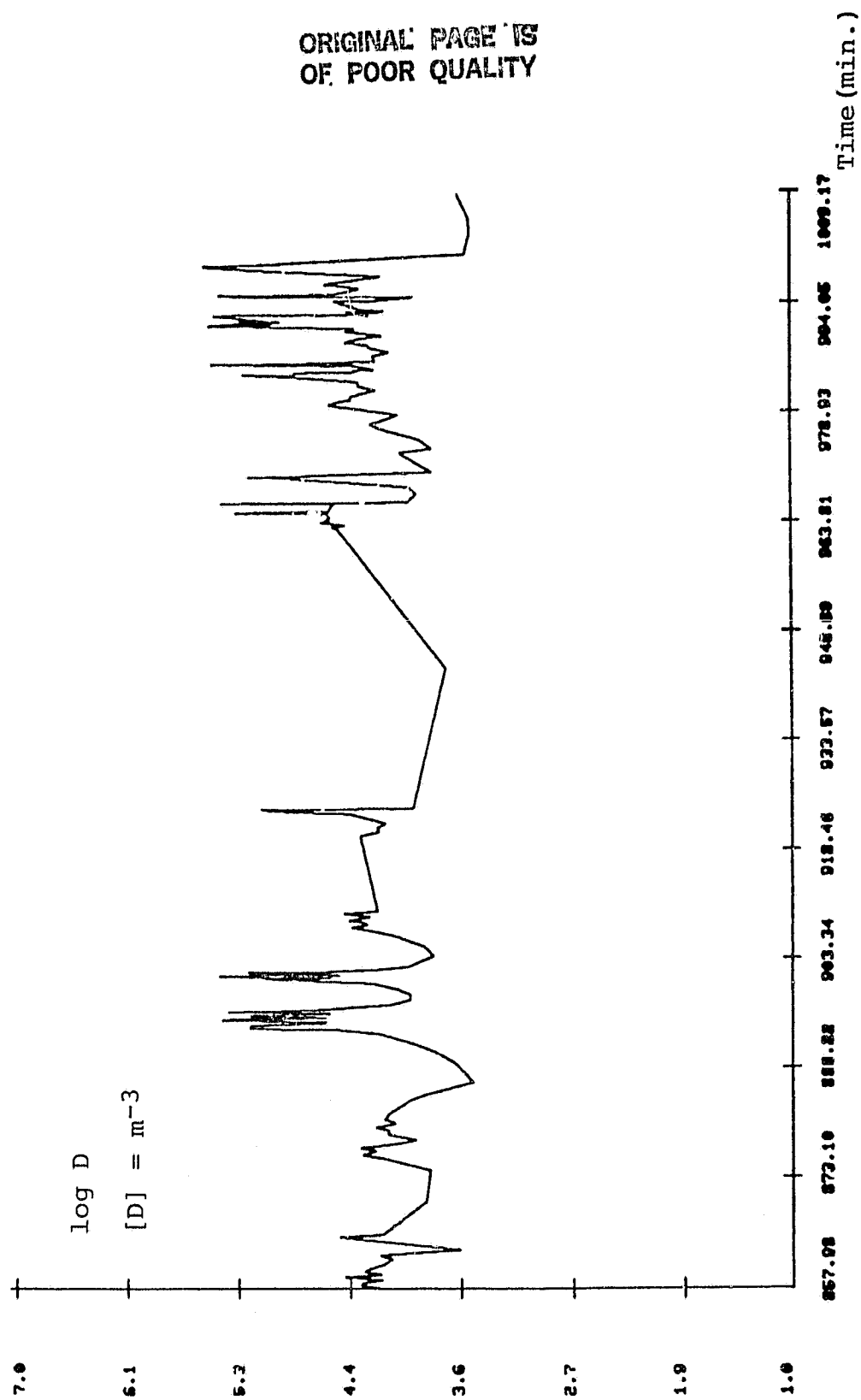


Fig. 65 Particle Density D

NUMBER 15 18

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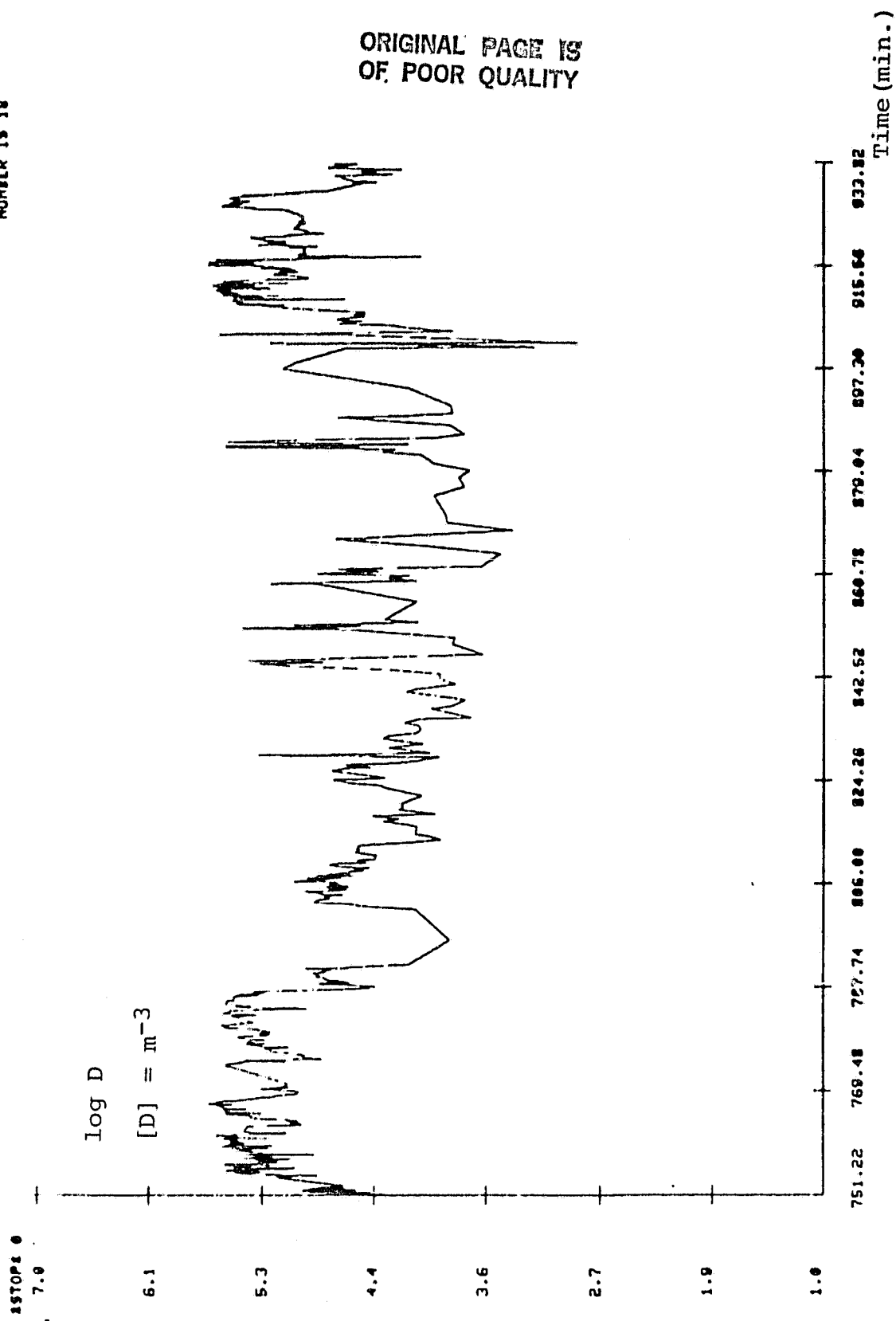


Fig. 66 Particle Density D

NUMBER IS 19

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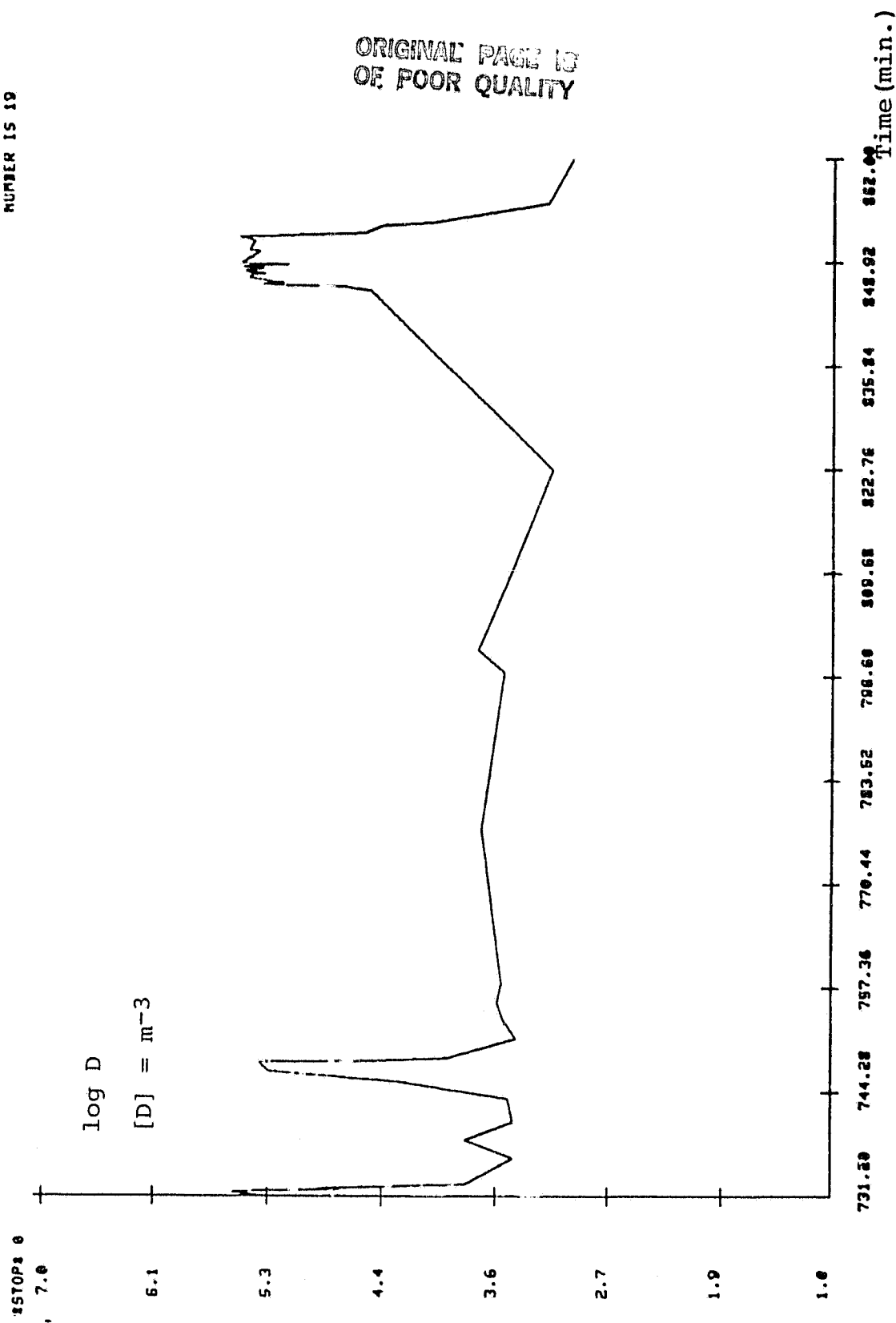
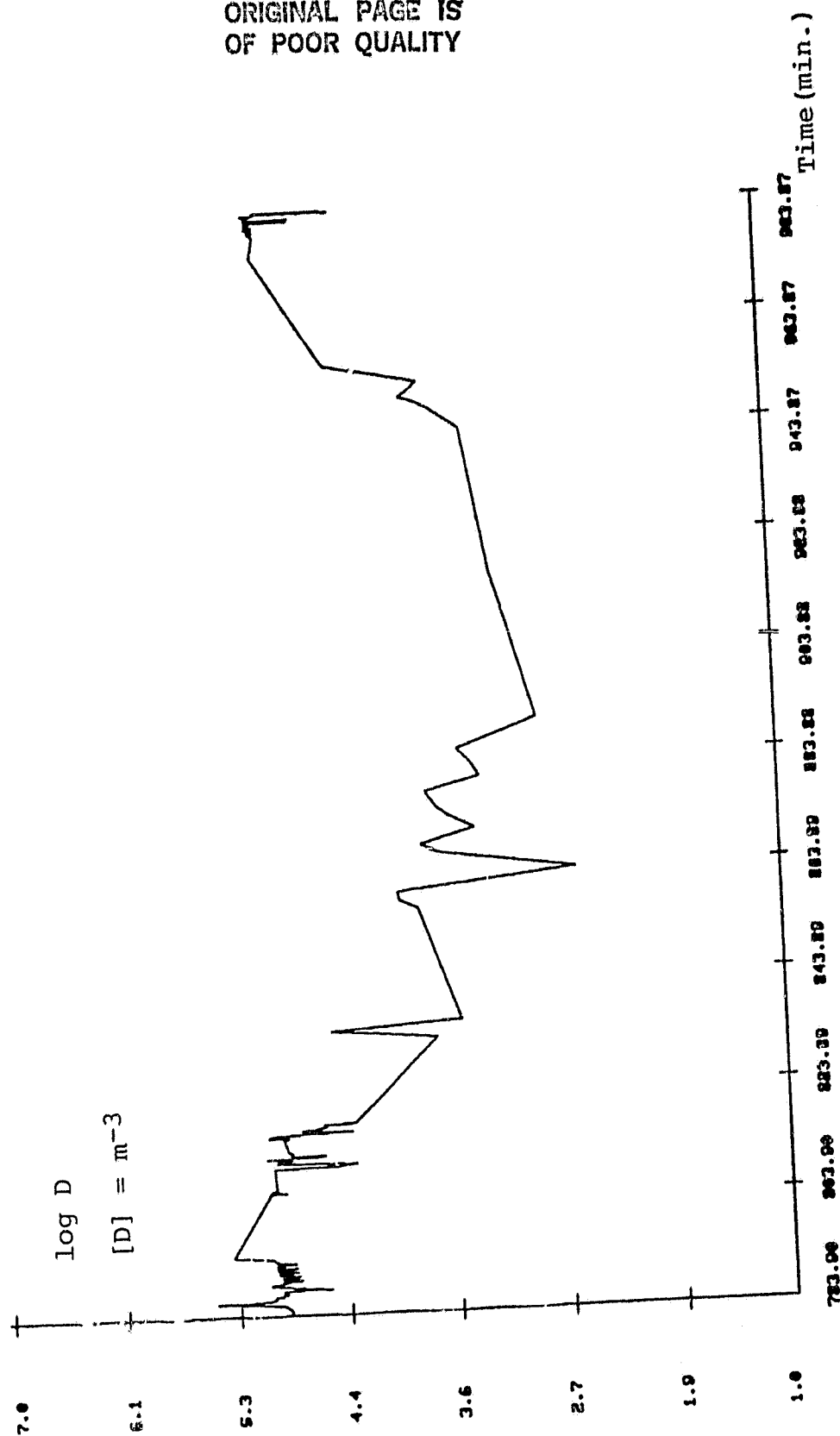


Fig. 67 Particle Density D

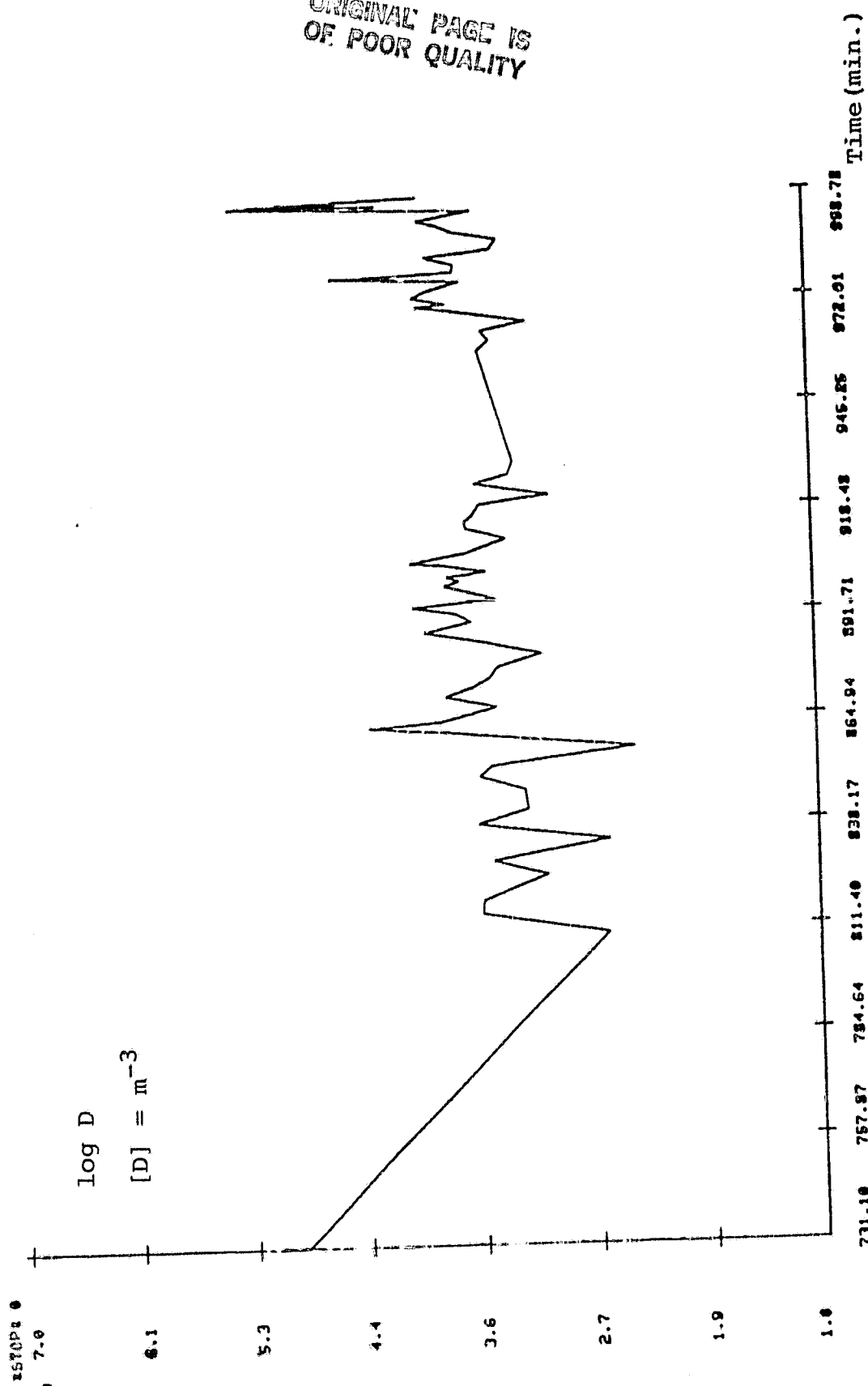
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Particle Density D

Fig. 68

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Particle Density D

Fig. 69

NUMBER 15 22

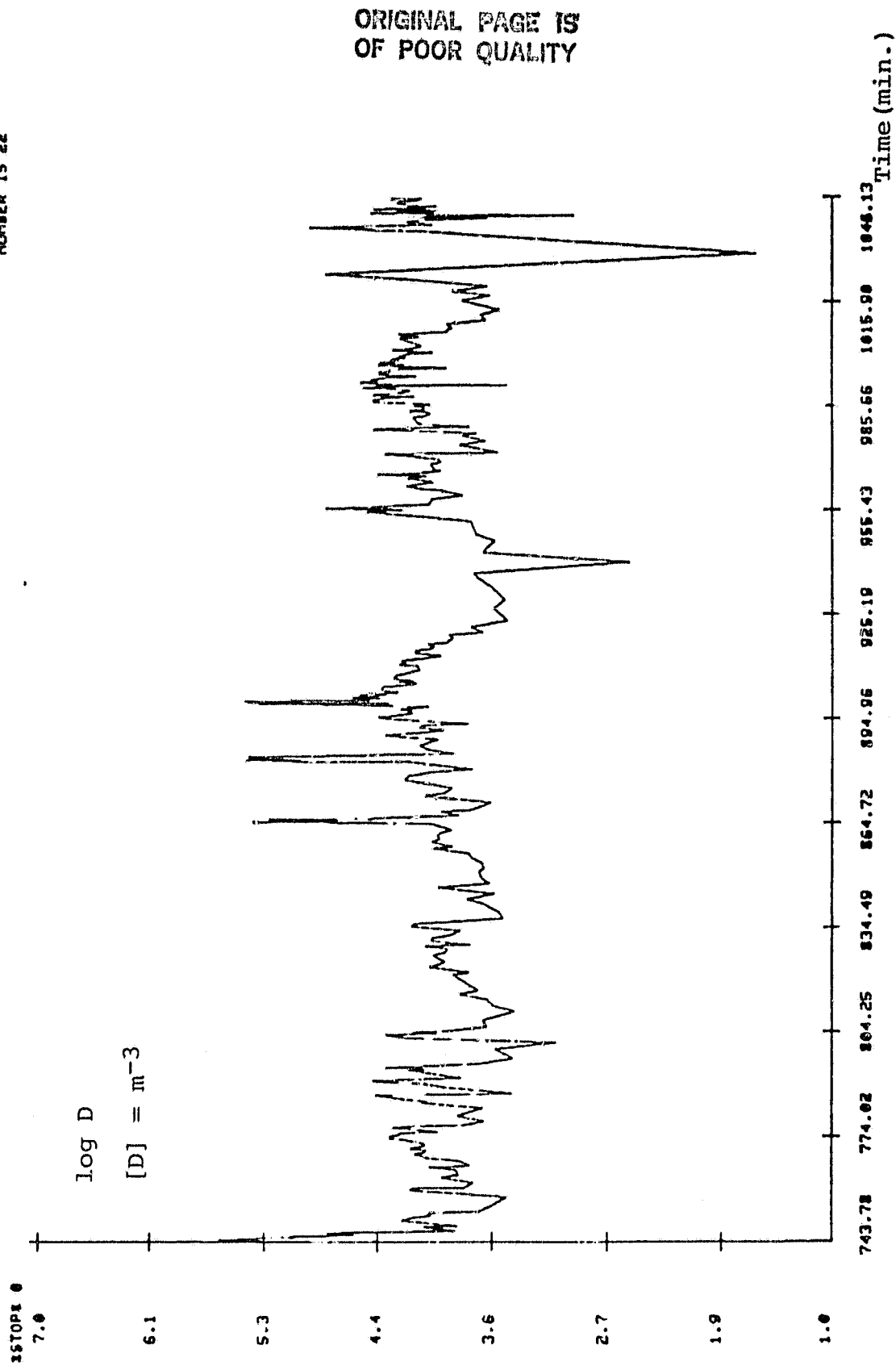
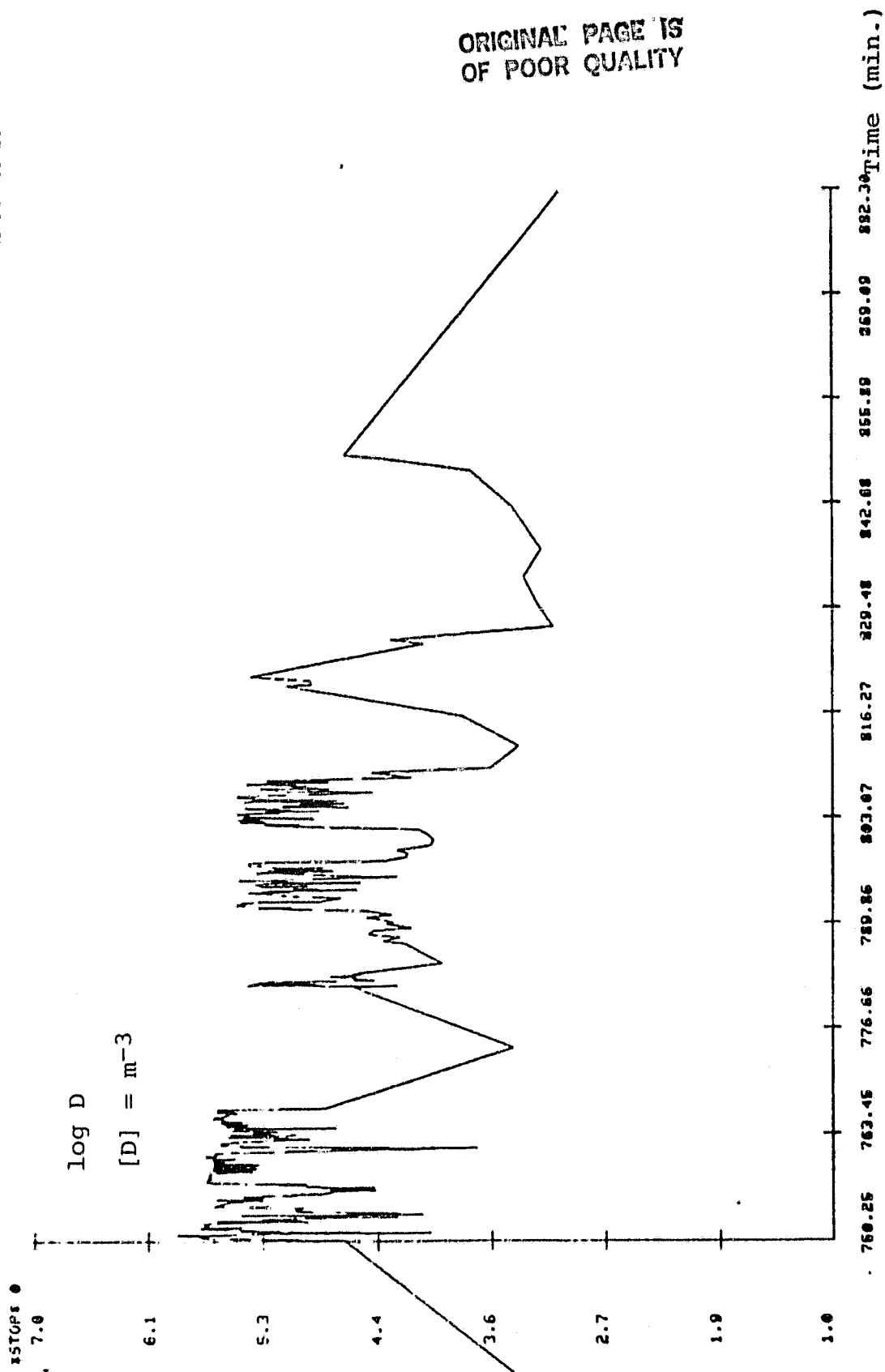


Fig. 70 Particle Density D

NUMBER IS 2J



Particle Density D

Fig. 71

3. LDV SIGNAL PROCESSING ANALYSIS AND SIMULATION

Applied Research has utilized and modified a signal processing code written by the Wave Propagation Laboratory of NOAA. This code was written for a Data General machine and utilized on the Sigma V computer at MSFC. Conversion and implementation of this code constituted a significant task. A listing of this code as it was utilized in this study is given in Appendix B. A flow chart of the complete code is given in Figure 72.

Basically the code is capable of generating a sinusoidal signal with noise or a narrow band random process signal with noise, and processing this signal according to selected algorithms to give frequency estimates. It is the narrow band signal which is appropriate for LDV studies. The code was used in these studies to generate the standard deviation of the mean frequency estimate as a function of the input signal-to-noise for a narrow band random process, over an ensemble of 1000 different cases for each point. This quantity leads directly to the expected velocity error for a given case.

Use of the Code

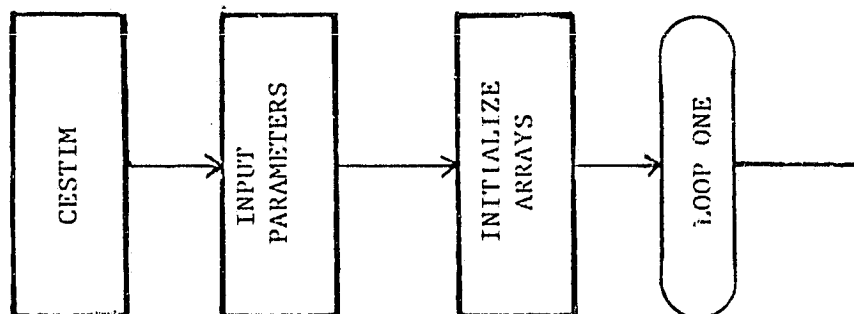
The signal processing program used by Applied Research, Inc. is listed on the NASA computer system as ARIDAN and XARIDAN. The ARIDAN is the fortran listing of the program, while XARIDAN is the executable source.

There are two ways of running the program. One is to execute a command file labeled DANCMD. This will set the logical unit number ten for terminal output. The second way is for the user to set the logical unit ten for a terminal output, then start XARIDAN.

Once the program has been started, data input will be requested. The

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Fig. 72 CESTIM FLOW CHART



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GET SIGNAL
(GETSIG)

PLOT
TIME
SERIES
?

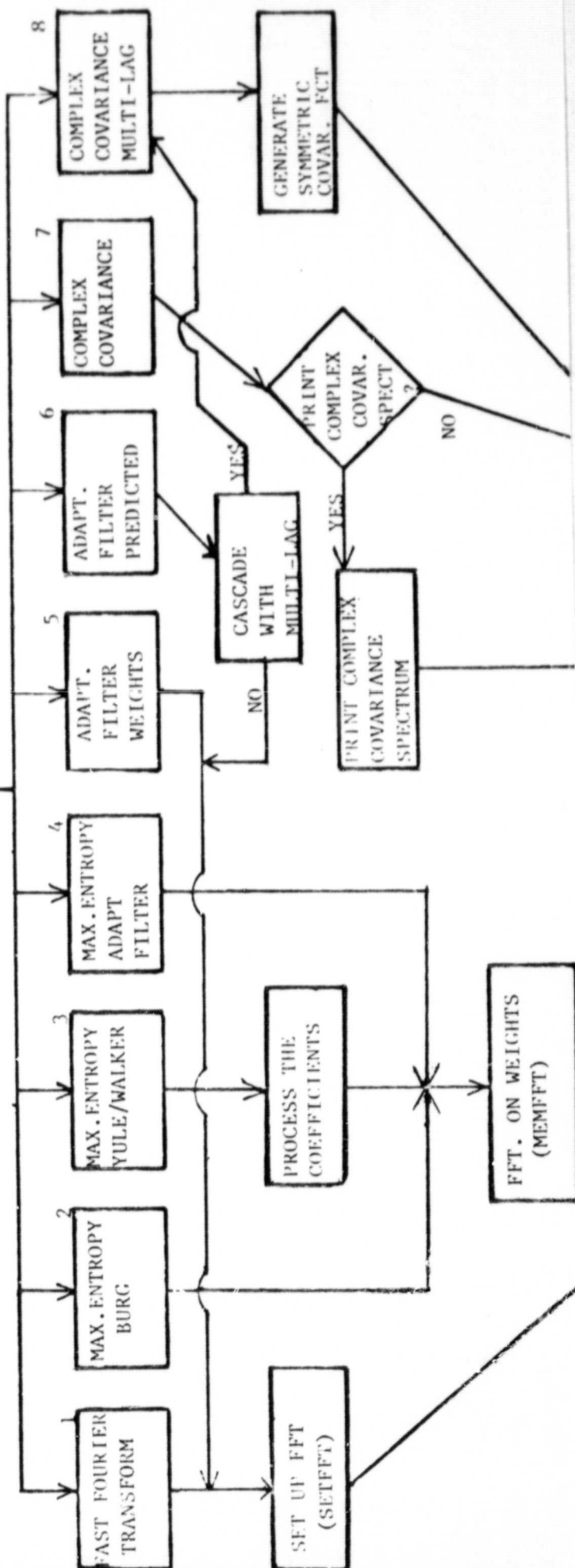
YES

PLOT
(TIMGRF)

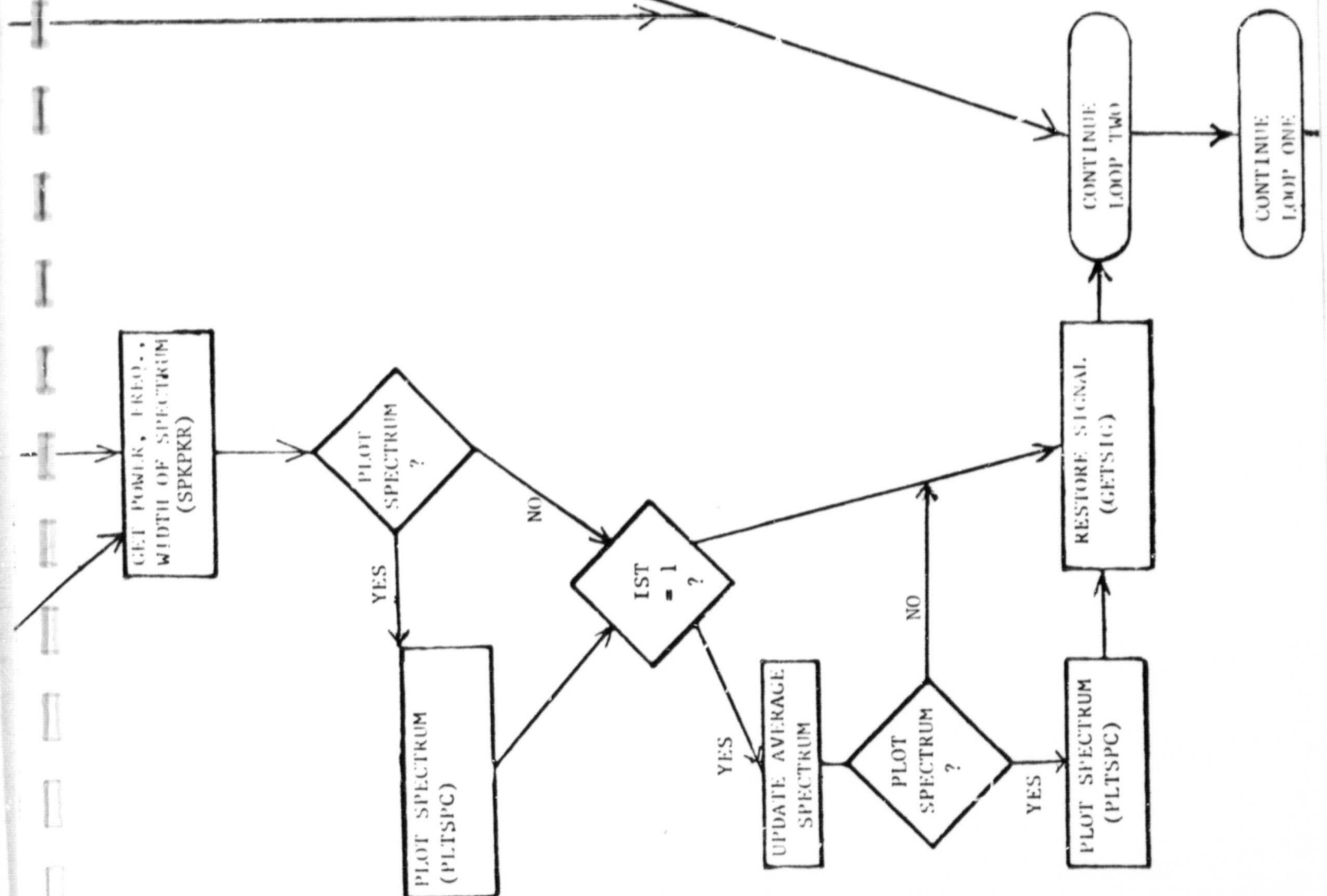
NO

LOOP TWO

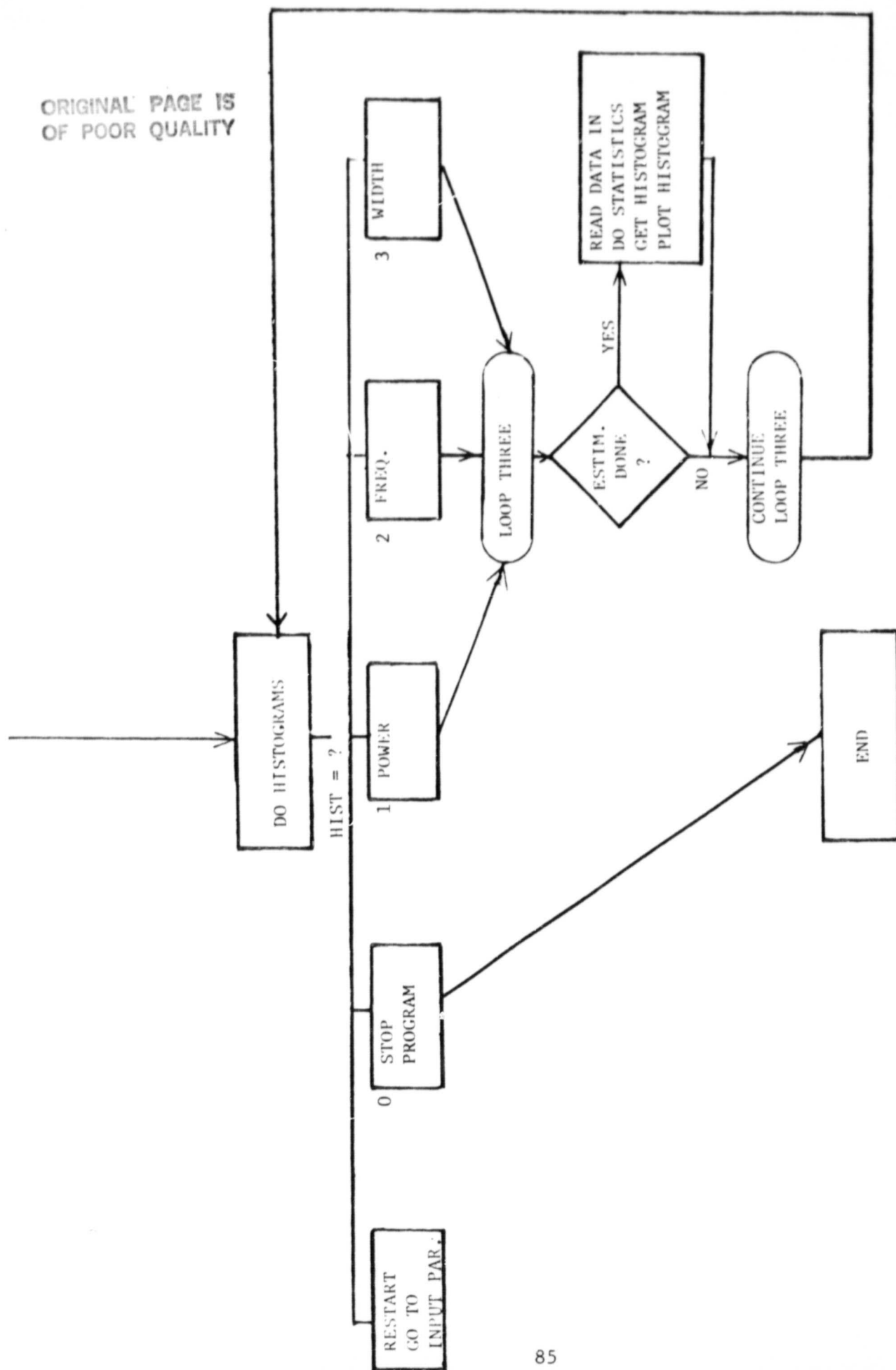
IST = ?



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program will need to know if the user wants sinusoidal or narrow band random process synthetic data. The program will then list the available estimators and give the user an option to use or not use them. Then depending on which estimators are being used, the program will ask for inputs needed to run those estimators.

Inputs that are common to every estimator are: (1) the frequency of synthetic data (FREQ); (2) for narrow band random processes, the standard deviation of the signal (SIGMA); (3) the signal to noise ratio of data (SNR); (4) the number of input data points (NTOT); (5) the length of the transform for spectrum (NPTS); (6) Hanning window for fourier transform (IWNDW); (7) the number of estimates (NEST); (8) type of spectrum plot (LOGSCL); and (9) does user want a hard copy of input parameters.

The number of input data points and the length of the transform determine the size of the signal generated. If NTOT is less than NPTS the program generates a signal of size NPTS. If NTOT is greater than NPTS the program will generate a signal with the size the closest power of two larger than NTOT.

When the Fast Fourier Transform estimator is used the system will ask for the FFT averaging time constant. This parameter is used to set the number of times a block average will be done.

When the Adaptive Filter - Weights estimator is used the system will need to know the order of the filter (LORD) and also the normalized adaptive constant (ALPHA).

When Adaptive Filter - Predicted estimator is used the system will need the same parameters as Adaptive Filter - Weights but will also require some others. The program will need to know the number of samples to use in the prediction filter. It will also want to know if user wants to cascade the

filter with the Multi-Lag Complex Covariance estimator. This option was added by Applied Research.

Finally, when the Multi-Lag Complex Covariance estimator is used the system will need to know the order of the estimator.

After inputs, the program will clear the screen and make the plot of the first time series and ask user if a hard copy is wanted.

The program will then proceed to the signal processing and a plot of the power spectrum for each estimator will be made. After the processing is done the terminal bell will ring twice and a question mark will be displayed. This gives the user the time to make a hard copy from the terminal and then press return to continue.

The program then clears display and asks the user if a histogram is wanted. Choices of histograms are power, frequency, and width. If user does not want a histogram, the user may either restart program without exiting, or end processing.

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In a previous report (Final Report on Contract No. NAS8-34337, June 1982) the application of adaptive filtering to LDV processing has been considered. It was seen (Figure 6.5) that an adaptive linear predictive filter (ALPF) offers several dB improvement over the pulse pair processor within a large range of S/N values for the input signal. However, the theoretical limit (Cramer-Rao Bound) for improvement is still beyond this, indicating that significant further improvement is possible. The poly-pulse-pair (PPP) processor was known to follow the linear predictive filter result but theoretical or simulated results for the ALPF preceding the PPP processor had not been obtained. Under the present task, results for the PPP processor (on the figure called multi-lag L=4 case), and the ALPF have been separately simulated. Then the two processors have been cascaded with the ALPF preceding the PPP. As a baseline, the result of an FFT on the input has been calculated using the multi-lag L=1 algorithm.

The processing simulated was taken to be appropriate to the MSFC pulsed system, with a sampling rate of 15 MHz. A Doppler frequency of 4.5 MHz was assumed, although this is incidental to the result. A narrow band random process signal was synthetically generated with a standard deviation of .02 yielding a velocity standard deviation of .48 m/sec for a total spread of about 1 m/sec. A data sequence of 64 points was used, corresponding to a 4 microsecond pulse with a length of 1200 meters.

The PPP processor was taken to have four lags, and the ALPF was taken to have four weights. The convergence factor, α , was taken to be .1 (See R. J. Keeler, NOAA Technical Memorandum ERL WPL-49, p. 15).

Figure 73 shows the result for the standard deviation of the velocity error in predicting the mean value for the several methods mentioned above as a function of the input signal-to-noise of the signal. One thousand spectral estimates were run to obtain each point. The ordinate of this figure should be multiplied by .795 to obtain the velocity error in meters per second. The results of this analysis are summarized as follows:

1. There is probably no significant difference in any of the methods at the extreme points ± 10 dB.
2. In between the extreme points, there is a region (near 5 dB) where the PPP method and the cascaded processor (ALPF followed by PPP) give the same result; there is a region (near 0 dB) where the PPP is slightly better (about .5 dB) than the cascaded processor; and there is a region (near -5 dB) where the cascaded processor is somewhat better (about 1 dB) than the PPP processor. The FFT (multi-lag order = 1) is the least desirable in all these cases, but serves as a standard of comparison.

The conclusion from the results is that optimum processing techniques may depend upon the signal-to-noise level. In such a case, a more detailed mapping of the various regions would be in order. This was not possible under the present contract because of the long run times required. However, these results indicate that the use of an adaptive filter as a part of the processing chain will lead to an improvement over the PPP processor of around one db for the pulsed LDV system near -5 db.

A remaining question which must be addressed concerns the convergence time of the adaptive filter. There is no theoretical work available at this time on this question for narrow band random processes, to the author's knowledge. These simulations have been guided by results for sinusoidal signals. It must yet be established that an adaptive filter can adapt using the amount of stationary data available in one or several LDV pulses.

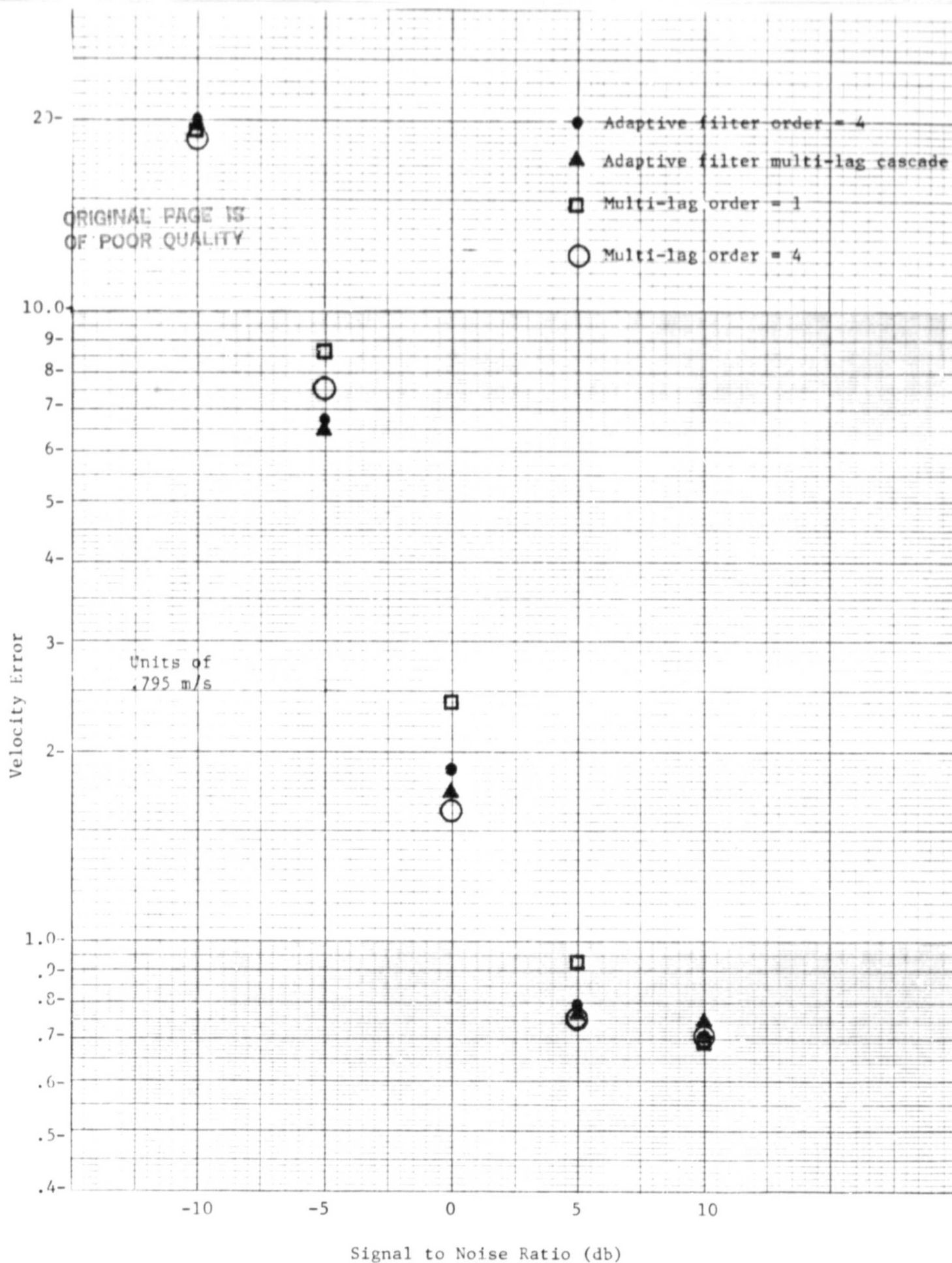


Fig. 73 Simulation Results

APPENDIX A. DATA PROCESSING CODE

```

1.000 C *****
2.000 C SET F15 M,IN *****
3.000 C SET F16 M,OUT *****
4.000 C SET F10 M,OUT *****
5.000 C SET F12/CALFIL4,IN *****
6.000 C *****
7.000 C *****
8.000 C *****
9.000 C *****
10.000 C *****
11.000 C *****
12.000 C *****
13.000 C *****
14.000 C *****
15.000 C *****
16.000 C *****
17.000 C *****
17.010 C IREC IS THE DATA RECORD COUNTER *****
17.100 C IREC=0 *****
18.000 C *****
19.000 C *****
20.000 C *****
21.000 137 *****
22.000 C *****
23.000 C *****
24.000 C *****
25.000 C *****
26.000 C *****
27.000 C *****
28.000 C *****
29.000 110 *****
30.000 100 *****
31.000 *****
32.000 *****
33.000 122 *****
34.000 *****
35.000 *****
36.000 *****
37.000 *****
38.000 *****
39.000 *****
40.000 *****
41.000 *****
42.000 *****
43.000 *****
44.000 *****
45.000 *****
46.000 40 *****
47.000 C *****
48.000 C *****
49.000 C *****
50.000 C *****
51.000 C *****
52.000 C *****
53.000 C *****
54.000 C *****
54.010 C *****
54.020 C *****
54.030 C *****
54.040 C *****
55.000 C *****
56.000 5 *****
56.010 *****

```

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```

56.100 IF (DATA(1).EQ.1E6) STOP
56.200 IREC = IREC + 1
57.018 IF (BUF(32) .GT. 150) GO TO 175
57.020 6 CONTINUE
58.000 CALL GETDAT(BUF, DATA)
58.010 IF (DATA(1).EQ.1E6) STOP
58.100 IREC=IREC+1
59.000 GO TO 5
60.000 175 CONTINUE
61.000 IF (KKK .CT. 0) GO TO 173
62.000 KSH = BUF(5)
63.000 KSM = BUF(6)
64.000 KSS = BUF(7)
65.000 KSF = BUF(8)
66.000 173 CONTINUE
67.000 IF (BUF(8) .LE. BUF(4)) GO TO 69
68.000 BUF(3) = BUF(3) - 1
69.000 BUF(4) = BUF(4) + 1000
70.000 69 NF = BUF(4) - BUF(8)
71.000 IF (BUF(7) .LE. BUF(3)) GO TO 71
72.000 BUF(2) = BUF(2) - 1
73.000 BUF(3) = BUF(3) + 60
74.000 71 NS = BUF(3) - BUF(7)
75.000 IF (BUF(6) .LE. BUF(2)) GO TO 73
76.000 BUF(1) = BUF(1) - 1
77.000 BUF(2) = BUF(2) + 60
78.000 73 NM = BUF(2) - BUF(6)
79.000 NH = BUF(1) - BUF(5)
80.000 KS = KS + (3600 * NH) + (60 * NM) + NS
81.000 KF = KF + NF
82.000 IF (KF .LT. 1000) GO TO 74
83.000 KF = KF - 1000
84.000 KS = KS + 1
85.000 74 CONTINUE
86.000 KBUF = KBUF + BUF(32)
87.000 KKK = KKK + 1
88.000 DO 50 I=1,256
89.000 ISUM=ISUM + DATA(I)
90.000 50 ISSIN(I) = ISBIN(I) + DATA(I)
91.000 ITR = ISL(BUF(15),16)
92.000 UB = IOR(ITR,BUF(16))
93.000 IFG = BUF(25)
94.000 NSUM = NSUM + BUF(17)
95.000 SUOL = SUOL + UB
96.000 INOISE = 0
98.000 C
99.000 C
100.000 C
101.000 C
105.000 C
106.000 CALL GETDAT(BUF, DATA)
106.010 IF (DATA(1).EQ.1E6) STOP
106.100 IREC=IREC+1
107.000 DO 60 L=1,256
108.000 ISN(L) = ISN(L) + DATA(L)
109.000 60 INOISE = INOISE + DATA(L)
110.000 ISUM=ISUM+INOISE
111.000 ITR = ISL(BUF(15),16)
112.000 UB = IOR(ITR,BUF(16))
113.000 IFG = BUF(25)
114.000 NSUM = NSUM + BUF(17)
115.000 60 SUOL = SUOL + UB
116.000 C
        OUTPUT ISUM
    
```

ISUM - THE TOTAL # OF PARTICLE HITS TO PROCESS
INOISE - THE NOISE SUM WHICH IS SUBTRACTED
FROM THE TOTAL # OF HITS

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116.500 C
117.000 C
118.000 C
119.000 C
120.000 C
121.000 C
122.000 C
123.000 C
124.000 C
125.000 C
126.000 C
127.000 C
128.000 C
129.000 C
130.000 C
131.000 C
132.000 C
133.000 C
134.000 C
135.000 C
136.000 C
137.000 C
138.000 C
139.000 C
140.000 C
141.000 C
142.000 C
143.000 C
144.000 C
145.000 C
146.000 C
147.000 C
148.000 C
149.000 C
150.000 C
151.000 C
152.000 C
153.000 C
154.000 C
155.000 C
156.000 C
157.000 C
158.000 C
159.000 C
160.000 C
161.000 C
162.000 C
163.000 C
164.000 C
165.000 C
166.000 C
167.000 C
168.000 C
169.000 C
170.000 C
171.000 C
172.000 C
173.000 C
174.000 C

OUTPUT ISUM, INOISE, ISRIM(256)
IF (ISUM - LE, 1000) GO TO 5

10000 PARTICLE COUNT, OR ABOVE MUST
BE OBTAINED BEFORE DATA IS SENT TO
INVERSION ALGORITHM

KCH = BUF(1)
KCM = BUF(2)
KCS = BUF(3)
KCF = BUF(4)
IF (KSF - LE, KCF) GO TO 269
KCS = KCS - 1
KCF = KCF + 1000
IFRAC = (KCF - KSF) / 2
IF (KSS - LE, KCS) GO TO 270
KCM = KCM - 1
KCS = KCS + 60

NSECS = (KCS - KSS) / 2
IF (KSM - LE, KCM) GO TO 271
KCM = KCM - 1
KSM = KSM + 60
NMM = (KCM - KSM) / 2
NHR = KCM - KSH
LF = KSF + IFRAC
IF (LF - LT, 1000) GO TO 231
LF = LF - 1000
KSS = KSS + 1
LS = KSS + NSECS
IF (LS - LT, 60) GO TO 232
LS = LS - 60
KSM = KSM + 1
LM = KSM + NMM
IF (LM - LT, 60) GO TO 234
LM = LM - 60
KSH = KSH + 1
LN = KSH + NHR
OUTPUT IREC
WRITE(6,178) UB,IFG,BUF(17)
FORMAT(1X,'UB,IFG,BUF(17)',F10.1,2I10)
DO 200 I=1,51
YBUF(I) = CAL(71-IFG,I)/500
CONTINUE

VB = THE ACCUMULATED VOLUME BETA COUNT IN THE NOISE
DATA
USIGL = INTEGRATED SIGNAL OBTAINED
AFTER TABLE LOOKUP
AND AFTER NOISE HAS BEEN SUBTRACTED
RUB = VOLUME BETA(AUG) COUNT FOR THE DATA
UNS = INTEGRATED NOISE OBTAINED AFTER
TABLE LOOKUP
FINALB = THE FINAL VOLUME BETA FOR THIS DATA
SET

THE INTEGRATED VOLUME BETA(RUB) IS MULTIPLIED BY A
BIDIRECTIONAL REFLECTANCE PARAMETER ( = .016 )
THEN DIVIDED BY THE SIGNAL RETURN FOR A
SANDPAPER DISK AT 10 METERS AT THE WAIST
( = 1.84289246 ) AND 14LM DIVIDED BY THE L-EFF
AT 10 METERS ( = 0.6407 ). SEE APPLIED
RESEARCH REPORTS FOR COMPLETE DOCUMENTATION.

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175.000 C
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209.000 10
210.000
211.000 55
212.000 C
213.000 C
214.000 C
215.000 C
216.000 C
217.000 C
218.000
219.000
220.000 300
221.000
222.000
223.000 C
223.500
224.000
225.000
226.000 C

UB = $VUL/NSUM
DBMS = YLIN(51,UB,YBUF,XNOISE)
RUB = $UOL/NSUM
SDBMS = YLIN(51,RUB,YBUF,XNOISE)
USIGL = 10*(SDBMS - DBMS)/10.
UNS = 10*(DBMS - RUB)
FINALB = USIGL/UNS*.016/1.842802/67.6407
OUTPUT DBMS
OUTPUT FINALB,USIGL,UNS,$VUL,$UOL,NSUM

UB IS USED TO EXTRACT A NOISE VALUE FOR
THIS SET OF SINGLE PARTICLE DATA
BY INTERPOLATING
THE CALIBRATION DATA (CAL(I,J))

DBMS = THE NOISE IN DBMS
ITHRESH = THE BIN WHERE THE SIGNALS ARE
THRESHOLDED - ABOVE ITHRESH CONTAINS
DATA
NP = THE NUMBER OF PARTICLES ARRAY -
CONTAINS NUMBER OF PARTICLE HITS IN THE
SELECTED BINS

THE FACTOR 1.5/.86 APPEARS IN THE NOISE
CALCULATION(DBMS) BECAUSE THIS IS THE
DIFFERENCE IN BANDWIDTH BETWEEN THE SINGLE
PARTICLE DATA AND THE VOLUME CHANNEL DATA

CHU = 10*(DBMS/10)
DBMSN = 10*LOG10(CHU*.5/.86)
DO 210 I = 1,M+1
SGL(I) = 10*(XSGL(I)-DBMSN)/10)
CONTINUE
OUTPUT SGL
K = ITHRESH + 1
DO 66 JJ = 1,22
MP(JJ) = 0
CONTINUE
DO 55 J = 1,M+1
KX = K+XDS(J)-1
DO 19 I = K,KK
MP(J) = MP(J) + ISBIN(I)-ISN(I)
CONTINUE
K = KX+1
CONTINUE
OUTPUT MP,ISBIN,ISN

DETERMINE SIGMAS THAT CORRESPOND TO SIGNAL BINS
1.EB - CONVERTS FROM CM12 TO MICRON12
1.10376E7 IS THE SINGLE PARTICLE GAIN AT AN AREA OF ZERO
DO 300 I = 1,M + 1
SIG(I) = SGL(I)*1.EB/1.10376E7
CONTINUE
300
SIL = SIG(I)
SIL = SIG(I) + 1
OUTPUT SIG
OUTPUT SIL,SIM
SIM = SIG(M+1)
OUTPUT ISUM

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ORIGINAL PAGE IS
OF POOR QUALITY

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227.000 C      DATANAL DOES ACTUAL INVERSION
228.000 C      CALL DATANAL(15UM,M,MS,US,UU)
229.000 C      ELS = KS + KF 1000.
230.000 C      FLTL = KBUF/XXX1-51441ELS
231.000 C      IF(UU.EQ.0) UU=1.1E3
232.000 C      SINGLES = 15UM/4/3.14159265359/FLTL/UUUS
233.000 C      OUTPUT SINGLES,FLTL,ELS
234.000 C
235.000 C      ELS - THE ELAPSED TIME IN SECS FOR WHICH DATA
236.000 C      WAS TAKEN
237.000 C      FLTL - THE FLIGHT LENGTH IN METERS
238.000 C      SINGLES - THE SINGLE PARTICLE BETA
239.000 C      US - THE AVERAGE CROSS-SECTION OF PARTICLE
240.000 C      SQUARE MICRONS
241.000 C      UU - THE AVERAGE SIZE OF THE TRANSVERSE
242.000 C      CROSS-SECTION OF FOCAL VOLUME
243.000 C      PREDICTED FROM INVERSION ALGORITHM
244.000 C
245.000 C      WRITE(6,702) BUF(9),BUF(10), BUF(11)
246.000 C      FORMAT(IX,'DATE',12,'-',12,'-',12)
247.000 C      WRITE (6,703) LM,LS,LF
248.000 C      FORMAT(IX,'TIME',12,'-',12,'-',12,'-',13)
249.000 C      WRITE(6,704)
250.000 C      FORMAT(13) LM,LS,LF,SINGLES,FINALB,US,FLTL,ELS,UU
251.000 C      ISUM = 0
252.000 C      INoise = 0
253.000 C      GO TO 122
254.000 C      STOP
255.000 C      END
256.000 C
257.000 C      10
258.000 C      CONTINUE
259.000 C      III=III+1
260.000 C      II=0
261.000 C      201
262.000 C      FORMAT(IX,6HBUFF,48(IX,818,7))
263.000 C      CALL BUFFER IN(5,1,BUFF,192,1STAT,MURD,1AB)
264.000 C      OUTPUT 1STAT,MURD,1AB
265.000 C      WRITE(6,301) (BUFF(I),I=1,384)
266.000 C      IF(1STAT.EQ.3) DATA(1)-1E6
267.000 C      IF(1STAT.EQ.3) RETURN
268.000 C      DO 300 I=1,384,2
269.000 C      II=II+1
270.000 C      II=IAND(BUFF(II),82FF000000)
271.000 C      I2=IAND(BUFF(II),8200FF0000)
272.000 C      I3=IAND(BUFF(II),820000FF00)
273.000 C      I4=IAND(BUFF(II),82000000FF)
274.000 C      I1=I2 II,-24)
275.000 C      I2=I5L(12,-8)
276.000 C      I3=I5L(13,-8)
277.000 C      I4=I5L(14,-8)
278.000 C      BUF(II)=IOR(I2,I1)
279.000 C      BUF(II)=IOR(I3,II)
280.000 C      CONTINUE
281.000 C      DO 100 K=1,20
282.000 C      ID(K)=BUF(K+48)
283.000 C      CONTINUE
284.000 C      100
285.000 C      200
286.000 C      300
287.000 C      400
288.000 C      500
289.000 C      600
290.000 C      700
291.000 C      800
292.000 C      900
293.000 C      1000
294.000 C      1100
295.000 C      1200
296.000 C      1300
297.000 C      1400
298.000 C      1500
299.000 C      1600
300.000 C      1700
301.000 C      1800
302.000 C      1900
303.000 C      2000
304.000 C      2100
305.000 C      2200
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307.000 C      2400
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310.000 C      2700
311.000 C      2800
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323.000 C      4000
324.000 C      4100
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959.000 C      67600
960.000 C      67700
961.000 C      67800
962.000 C      67900
963.000 C      68000
964.000 C      68100
965.000 C      68200
966.000 C      68300
967.000 C      68400
968.000 C      68500
969.000 C      68600
970.000 C      68700
971.000 C      68800
972.000 C      68900
973.000 C      69000
974.000 C      69100
975.000 C      69200
976.000 C      69300
977.000 C      69400
978.000 C      69500
979.000 C      69600
980.000 C      69700
981.000 C      69800
982.000 C      69900
983.000 C      70000
984.000 C      70100
985.000 C      70200
98
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270.000 001 200 L-1.250
280.000 DATA(L)-BUF(L+128)
291.000 CONTINUE
292.000 *****
293.000 CH - CURRENT TIME HOURS
294.000 CM - CURRENT TIME MINUTES
295.000 CS - CURRENT TIME SECONDS
296.000 CF - CURRENT TIME FRACTIONS
297.000 SH - START OF RECORD HOUR
298.000 SM - START OF RECORD MINUTE
299.000 SS - START OF RECORD SECOND
300.000 SF - START OF RECORD FRACTION
301.000 DT - NUMBER BEFORE DIS. THRESHOLD
302.000 DB - DISCRIMINATOR THRESHOLD
303.000 FBI - NUMBER BEFORE FORWARD/AFT IDENTIFIER
304.000 FI - FORWARD/AFT IDENTIFIER
305.000 DATA - DATA
306.000 ID - IDENTIFICATION STRING
307.000 *****
308.000 CH-BUF(1)
309.000 CM-BUF(2)
310.000 CS-BUF(3)
311.000 CF-BUF(4)
312.000 SH-BUF(5)
313.000 SM-BUF(6)
314.000 SS-BUF(7)
315.000 SF-BUF(8)
316.000 DT-BUF(23)
317.000 DB-BUF(25)
318.000 FBI-BUF(25)
319.000 FI-BUF(26)
320.000 WRITE(6,401) SH,SM,SS,SF
321.000 FORMAT(1X,'START TIME: ',4I10)
322.000 WRITE(6,402) CH,CM,CS,CF
323.000 WRITE(6,403) BUF(15),BUF(16),BUF(17)
324.000 FORMAT(1X,'VOLUME BETA INT',3I10)
325.000 WRITE(6,404) DT
326.000 WRITE(6,405) DT
327.000 FORMAT(1X,'DISCRIMINATOR THRESHOLD ',1I0)
328.000 WRITE(6,406) BUF(25)
329.000 FORMAT(1X,'IF GAIN',1I0)
330.000 WRITE(6,407) FI
331.000 FORMAT(1X,'FORWARD/AFT ID ',1I0)
332.000 WRITE(10) (ID(1),1-1,20)
333.000 WRITE(6,120) (DATA(1),1-1,128)
334.000 FORMAT(1X,16(1X,8I8,/)
335.000 IF (111.GT.500) RETURN
336.000 RETURN
337.000 END
338.000
339.000 SUBROUTINE DATAMAL(MT,M,RS,US,WU)
340.000 DIMENSION DAND(16),2)
341.000 DIMENSION VY(125),AR(125)
342.000 COMMON/OPT/DS(22),NP(22),FSI,FM
343.000 COMMON/ARE/F(2),AL,RL,R1,A
344.000 COMMON/ET/AR(10),DSR,SRMX,AXX(101)
345.000 COMMON/... SIG(22),SGL(22),UI
346.000 COMMON/... YI(2),Z(2)
347.000 DATA PU,ETH,3U,RO,F,AL,AM,NI,FSI/5,...05,
348.000 1,1.E+6,.046,10.,10.,1.,J.1622777,30,1.973/
349.000 DATA P1,HP,CL,FIDA
350.000 1/3.14159,6.02562E-34,3.E+8,10.6E-6/

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341.000 DATA B,IP/1.5,1/
342.000 DATA ARR/3182.4E5,2.30E5,2.30E5,2.30E5,2.30E5,2.30E5,
343.000 1 2.36E5,2.34E5,2.12E5,2.31E5,2.30E5,2.30E5,2.12.20E5,
344.000 1 2.28E5,2.27E5,2.25E5,2.22E5,2.20E5,2.19E5,2.16E5,
345.000 1 2.12E5,2.11E5,2.10E5,2.1E5,2.05E5,2.01E5,1.98E5,1.92E5,
346.000 1 1.80E5,1.80E5,1.80E5,1.76E5,1.72E5,1.69E5,1.65E5,
347.000 1 1.60E5,1.57E5,1.53E5,1.50E5,1.46E5,1.43E5,1.38E5,1.36E5,
348.000 1 1.32E5,1.25E5,1.19E5,1.13E5,1.07E5,1.03E5,9.7E4,
349.000 1 9.3E4,8.9E4,8.6E4,8.3E4,7.7E4,7.5E4,7.3E4,6.9E4,
350.000 1 6.6E4,6.2E4,5.6E4,5.2E4,4.8E4,4.5E4,4.2E4,3.9E4,3.7E4,
351.000 1 3.5E4,2.9E4,2.6E4,2.3E4,2.1E4,1.9E4,1.8E4,1.75E4,
352.000 1 1.52E4,1.40E4,1.3E4,1.2E4,1.1E4,1.03E4,9.7E3,9.2E3,
353.000 1 8.6E3,8.1E3,7.5E3,7.2E3,6.3E3,5.6E3,5.0E3,4.5E3,
354.000 1 4.0E3,3.5E3/
355.000 DATA VV/0.01,0.02,0.03,0.04,0.05,0.06,0.07,0.08,0.09,
356.000 A 10.11.12.13.14.15.16.17.18.19.20,
357.000 A 21.22.23.24.25.26.27.28.29.30,
358.000 A 32.33.36.38.40.42.44.46.48.50.52.54.56,
359.000 A 58.60.65.70.75.80.85.90.95.100.101.102.103,
360.000 A 1.4.1.5.1.6.1.7.1.8.1.9.2.0.2.1.2.2.3.2.4.2.5,
361.000 A 2.6.2.7.2.8.2.9.3.0.3.2.3.4.3.6.3.8.4.9.4.2.4.4.6,
362.000 A 4.8.5.0.5.2.5.4.5.6.5.8.6.0.6.5.7.0.7.5.8.0.8.5.9.0,
363.000 A 9.5.10.0.11.12.13.14.15.16.17.18.19.20.21.,
364.000 A 22.23.24.25.26.27.28.29.30.32.34.36.38.,
365.000 A 40.42./
366.000 DATA TRANS/45.99/
367.000 DATA N/3E6/
368.000 DATA ITEST/1/
369.000 IF (ITEST.EQ. 9) GO TO 744
370.000 DO 998 I=1,123
371.000 ARR(I) = (ARR(I) * TRANS) * IE-8
372.000 CONTINUE
373.000 C
374.000 C
375.000 C
376.000 C
377.000 C
378.000 C
379.000 C
380.000 C
381.000 C
382.000 C
383.000 C
384.000 C
385.000 C
386.000 C
387.000 C
388.000 C
389.000 C
390.000 C
391.000 C
392.000 C
393.000 C
394.000 C
395.000 C
396.000 C
397.000 C
398.000 C
399.000 C
400.000 C

DATA TRANS/45.99/
DATA N/3E6/
DATA ITEST/1/
IF (ITEST.EQ. 9) GO TO 744
DO 998 I=1,123
ARR(I) = (ARR(I) * TRANS) * IE-8
CONTINUE

TRANS IS THE MULTIPLICATIVE FACTOR THAT CORRECTS
THE AREA CURVE
SO THAT THE AREAS CORRESPOND TO THE PROPER S/N/SIGMA

1.E-4 IS USED TO CONVERT THE AREAS FROM CM12 TO M12

DO 998 I = 1,123
VV(I) = VV(I) * IE-4
CONTINUE
DO 77 I = 1,123
J = 124 - I
IF (I.GT.J) GO TO 78
ATEMP = ARR(I)
ARR(I) = ARR(J)
ARR(J) = ATEMP
VTEMP = VV(I)
VV(I) = VV(J)
VV(J) = VTEMP
CONTINUE
77 CONTINUE
78 CONTINUE
ITEST = 0
A1 = AXFLDAXFLDAXETA/BU
A=1/(16.8PI*PI*PI)1.E-12
RD=PI*RO*RO/FLD
ALP=RD/F(1)
A1=RO/2./RD
RE01=F(1)*A1
RE02=F(12)*A1
Q1=A/(RE01*RE01*RE01)
Q2=A/(RE02*RE02*RE02)

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401.000 DO 4 I = 1,M
402.000 DS(I) = SIG(I+1) - SIG(I)
403.000 CONTINUE
404.000 X(1) = 0.
405.000 Y(1) = 0.
406.000 Z(1) = 0.
407.000 SIL = SIG(1)
408.000 SIH = SIG(M+1)
409.000 SRMH = SGL(1)/SIH
410.000 SRMX = SGL(1)/SIL
411.000 ALS = 1. + ALP*ALP
412.000 G = SORT(SRMX/SRMH)
413.000 SO = SORT((O-1.)*ALS+1.)
414.000 DSR = (SRMX-SRMH)/100.
415.000 NPTS = 101
416.000 C OUTPUT ARR,VV
417.000 DO 2 I = 1,NPTS
418.000 J = NPTS - I + 1
419.000 SR = SRMX - DSR * (I-1)
420.000 AXX,J) = SR
421.000 AR(J) = YLIN(123,SR,ARR,VV)
422.000 CONTINUE
423.000 C OUTPUT AXX,AR
424.000 C WRITE(103)((DAND(1,1),I-1,101),(DAND(1,2),I-1,101)
425.000 C GOTD 65
426.000 C CALL AREA(AT,SRMH)
427.000 C CALL AREA(AT1,SRMH)
428.000 C OUTPUT AT,AT1
429.000 C OUTPUT RD,ALP,ALS,G,SO,F(I)
430.000 C OUTPUT SRMH,SRMX,(SIG(1),I-1,MS+1),(SGL(1),I-1,M+1),XL,YL,ZL
431.000 C CALL OPTIMB,NT,M,MS,NI,IP,US,VV,ARR)
432.000 TSIA=NTUS
433.000 C OUTPUT VV,US
434.000 C OUTPUT TSIA
435.000 IF(UV.EQ.0.) VU=1.E-30
436.000 85 = NTUS/VU
437.000 BM = 4.35MP*ELDA/A1
438.000 479 FORMAT(6112)
439.000 489 PETUPH
440.000 65
441.000 C
442.000 C
443.000 SUBROUTINE SP5(S,SI,J)
444.000 COMMON/ARE/F(2),AL,RD,R1,A
445.000 COMMON/SS/X(2),Y(2),Z(2)
446.000 IF(J.EQ.1)X(1)=0
447.000 RS=X(J)*X(J)+Y(J)*Y(J)
448.000 ALP=RD/(F(J)+Z(J))
449.000 GA=1./SORT(1+(ALP*Z(J)/F(J))**2)
450.000 RE=(F(J)+Z(J))*R1/GA
451.000 E=RS/RE/RE
452.000 FE=EXP(-E)
453.000 911=S/FE
454.000 SI=(SI1RE**4)/A
455.000 RETURN
456.000 C
457.000 C
458.000 C
459.000 SUBROUTINE AREA1(ARA,SR)
460.000 COMMON/ARE1/AR1,LSR,SRMX
461.000 U=(SRMX-SR)/DSR
462.000 NI=U

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463.000 IF(NI.GT.99) GO TO 1
464.000 Z-U-NI
465.000 ARA-AR(NI+1)S(1-Z)+Z*AR(NI+2)
466.000 GO TO 3
467.000 1 CONTINUE
468.000 2 FORMAT(5AREA TABLE MAX9)
469.000 ARA-AR(101)
470.000 3 RETURN
471.000 END
472.000 C
473.000 SUBROUTINE AREA(ARA,S)
474.000 COMMON/ARE/F(2),AL,RD,R1,A
475.000 COMMON/ARE1/AR(101),DSR,SRMX
476.000 ALS=1.+AL*AL
477.000 G=SQRT(SRMX/S)
478.000 G=0-1
479.000 IF(G.LT.0.) OUTPUT G,S;GO TO 3
480.000 50=SQRT(G*ALS+1.)
481.000 ZM=ISO*1.)S(1)/ALS
482.000 DEL-ZM/F(1)
483.000 DZ-ZM/100.
484.000 ARA=0.
485.000 IT=0
486.000 DO 1 1=1,204
487.000 ZA-ZM-DZ*(1-2)
488.000 ALP-RD/(F(1)+ZA)
489.000 GA=1./SQRT(1.+(ALP*ZA/F(1)))S(2)
490.000 RE=(F(1)+ZA)*R1/GA
491.000 AR=A/(58*RE*RE*RE)
492.000 FL=LOG(AR)
493.000 IF(FL.LT.0.) IT=1;GO TO 1
494.000 ARA=RE*SQRT(FL)+ARA
495.000 1 CONTINUE
496.000 ARA-ARA*2.*DZ
497.000 IF(IT.EQ.0) WRITE(108,2)
498.000 2 FORMAT(8INTEGRATION RESTRICTED9)
499.000 3 CONTINUE
500.000 RETURN
501.000 END
502.000 C
503.000 SUBROUTINE SSP(S,SI,J)
504.000 COMMON/ARE/F(2),AL,RD,R1,A
505.000 COMMON/SS/X(2),Y(2),Z(2)
506.000 IF(J.EQ.1) X(1)=0.
507.000 RS=X(J)*X(J)+Y(J)*Y(J)
508.000 ALP-RD/(F(J)+Z(J))
509.000 GA=1./SQRT(1.+(ALP*Z(J)/F(J)))S(2)
510.000 RE=(F(J)+Z(J))*R1/GA
511.000 S=AR*SI/(RE*RE*RE*RE)
512.000 513.000 E-RS/RE/RE
514.000 FE=EXP(-E)
515.000 S=SAFE
516.000 RETURN
517.000 END
518.000 C
519.000 SUBROUTINE COEF2(C,I,J,K,DJ,M)
520.000 COMMON/COE2/SIQ(22),SG1(22),UI
521.000 COMMON/ARE1/AR(101),DSR,SRMX,MAX(101)
522.000 A2=0.
523.000 51=SIQ(J)+(K-1)*DJ
524.000 526.000

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526.000 SR=SQL(1)/SI
527.000 A1 = YLIN(101,SR,AXX,AR)
528.000 IF(1.GT.M+1) GO TO 1
529.000 JF(1.EQ.J) GO TO 1
530.000 SA=SQL(1+1)/SI
531.000 A2 = YLIN(101,SR,AXX,AR)
532.000 1 C -A1-A2
533.000 RETURN
534.000 END
535.000 C
536.000 C
537.000 SUBROUTINE LPICK(SIG,MS,BP1,BP,DB,ALP,DALP)
538.000 DIMENSION SIG(22)
539.000 DB=(SIG(MS+1)-SIG(1))/20.
540.000 BP=(SIG(1)+SIG(MS+1))/2.
541.000 A1=SQRT(LOG(SIG(MS+1))/2./SIG(1))*LOG(SIG(1))/2./SIG(1)
542.000 1 /LOG(SIG(MS+1))-LOG(SIG(1))/SIG(1)
543.000 DALP=A1/20.
544.000 ALP=A1/2.
545.000 RETURN
546.000 END
547.000 C
548.000 C
549.000 SUBROUTINE EPICK(SIG,BP1,BP,MS,DP)
550.000 DIMENSION SIG(22)
551.000 S1=BP1*LOG(SIG(1))/SIG(1)
552.000 S2=BP1*LOG(SIG(MS+1))/SIG(MS+1)
553.000 BP=S2
554.000 DP=(S1-S2)/25.
555.000 RETURN
556.000 END
557.000 C
558.000 C
559.000 SUBROUTINE PROW(IP,SIP,M)
560.000 COMMON/COE2/SIG(22),SGL(22),U
561.000 COMMON/ALN/50,A3
562.000 OUTPUT IP,BP,SIP
563.000 IF(SIP.LE.0.) OUTPUT SIP
564.000 IF(SIP.LE.0.) U=0
565.000 IF(SIP.LE.0.) RETURN
566.000 GOTO (1,2,3)IP
567.000 1 X=1.-BP
568.000 A1=(SIG(1)+X-SIG(M+1))/X
569.000 IF(BP.GT..999.AND.BP.LT.1.001)A1=LOG(SIG(M+1))/SIG(1)
570.000 U=(SIP*(1.-BP))/A1
571.000 RETURN
572.000 2 A2=(EXP(-BP*SIG(1))-EXP(-BP*SIG(M+1)))/BP
573.000 U=EXP(-BP*SIP)/A2
574.000 RETURN
575.000 3 U=(EXP(-(LOG(SIP)-LOG(BP))*2/2./SGL(22)))/A3
576.000 RETURN
577.000 END
578.000 C
579.000 C
580.000 SUBROUTINE OPTIM(B,M,N,MS,NI,IP,US8,UVS,VV,ARR)
581.000 DIMENSION PN(22)
582.000 DIMENSION ARR(125),VV(125)
583.000 COMMON/OPT/VS(22),NP(22),FSI,FN
584.000 COMMON/COE2/SIG(22),SGL(22),UI
585.000 COMMON/ALN/50,A1
586.000 COMMON/APE1/AR(101),DSR,SRMX,AXX(101)
587.000 OUTPUT 1/,B
588.000 B=2.5

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587.000 NC-0
590.000 IP-1
591.000 IC-0
592.000 BP-0
593.000 IT-0
594.000 BP-0
595.000 DP-1
596.000 CONTINUE
597.000 II-0
598.000 RM-1.E+60
599.000 IF(MC.GT.1)IC-1
600.000 IF(IC.EQ.1)NC-0
601.000 IP-2
602.000 IF(IC.EQ.0)IP-1
603.000 IF(IT.GE.2)IP-3
604.000 IC-0
605.000 C
606.000 C
607.000 C
608.000 C
609.000 C
610.000 C
611.000 C
612.000 C
613.000 C
614.000 C
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631.000 C
632.000 C
633.000 C
634.000 C
635.000 C
636.000 C
637.000 C
638.000 C
639.000 C
640.000 C

10
NC-0
IP-1
IC-0
BP-0
IT-0
BP-0
DP-1
CONTINUE
II-0
RM-1.E+60
IF(MC.GT.1)IC-1
IF(IC.EQ.1)NC-0
IP-2
IF(IC.EQ.0)IP-1
IF(IT.GE.2)IP-3
IC-0

TEMPORARILY THIS DEFEATS THE EXP AND LOG-NORMAL SOLNS

IF(IP.EQ.2) RETURN
IF(IP.EQ.2) CALL EPICK(SIG,BP1,BP,MS,DB)
IF(IT.EQ.2)CALL LPICK(SIG,MS,BP1,AM,DB,SO,DALP)
CONTINUE
8
II-11+1
IF(II.GT.100) RETURN
IF(BP.LT.0.-AND.IP.EQ.1) RETURN
IF(IP.LE.2)GOTO 102
AM-AM+DB
IF(AM.LT.1.) DB=0.
IF(AM.LT.1.) AM=ABS(AM/10)
IF(IT.EQ.3)SO=SO+DALP
IF(IT.EQ.3)AM=BP1

NORMALIZATION OF LOG-NORMAL DISTRIBUTION
A1=0.
DO 101 J=1,MS
DJ=D5(J)/NI
DO 100 K=1,NI+1
SIP=SIG(J)+(K-1)*DJ
V=EXP(-(LOG(SIP)-LOG(AM))**2/2./SO**2)
A1=A1+V*DJ
S11=SIG(J)
S12=SIG(J)+1
V1=EXP(-(LOG(S11)-LOG(AM))**2/2./SO**2)
V2=EXP(-(LOG(S12)-LOG(AM))**2/2./SO**2)
A1=A1-.5*(V1+V2)*DJ
B5=AM-DB
OUTPUT SO,A1
CONTINUE
102
DO 5 I=1,MS
5 PN(I)=0.
BP=BP+DB
IF(IT.EQ.3)BP=BP1
OUTPUT BP
US=0.
UU=0.
DO500 J=1,MS
DJ=D5(J)/NI
DO 501 K=1,NI +1
SIP=SIG(J)+(K-1)*DJ
SR=SGL(I)/SIP
ASK=VLIN(101,SR,AXX,AR)

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642.000 CALL PROV(BP,IP,SIP,MS)
643.000 US-US+U1X5IP2DJ
644.000 UU-UU+U1ASK2DJ
501 645.000 S11-SIG(J)
646.000 S12-SIG(J+1)
647.000 SR-SOL(1)+SIG(J)
648.000 AS1-YLIN(101,SR,AXX,AR)
649.000 SR-SOL(1)+S12
650.000 AS2-YLIN(101,SR,AXX,AR)
651.000 CALL PROV(BP,IP,S11,MS)
652.000 U1-U1
653.000 CALL PROV(BP,IP,S12,MS)
654.000 U2-U1
655.000 US-US-.5X(U1X5I1+U2X5I2)2DJ
500 656.000 UU-UU-.5X(U1X5I1+U2X5I2)2DJ
657.000 US-US11.E-12
658.000 USS-US1
659.000 UUS-UU1
660.000 US1-US
661.000 JU1-UU
662.000 FN-N
663.000 DNT-FN/UU
664.000 BT-DNTXUS
665.000 DO 1 I=1,M+1
666.000 DO 1 J=1,MS
667.000 DJ-DS(J)/NI
668.000 DO 4 K=1,MI+1
669.000 SIP-SIG(J)+(K-1)2DJ
670.000 CALL PROV(BP,IP,SIP,MS)
671.000 CALL COEF2(C1,I,J,K,DJ,M)
4 672.000 PN(1)=PN(1)+C1UI2DJ
673.000 SIP-SIG(J)
674.000 CALL PPOU(BP,IP,SIP,MS)
675.000 U1-U1
676.000 SIP-SIG(J)+NI2DJ
677.000 CALL PROV(BP,IP,SIP,MS)
678.000 U2-U1
679.000 CALL COEF2(C1,I,J,I,DJ,M)
680.000 CALL COEF2(C2,I,J,NI+1,DJ,M)
1 681.000 PN(1)=PN(1)-.5X(C1XU1+C2XU2)2DJ
682.000 R=0
683.000 DO 2 I=1,MS
684.000 FN=NP(I)
685.000 FP=PN(1)2DNT
686.000 C OUTPUT R,FN,FP,I
687.000 IF(I.LE.M) R=(FN-FP)222+R
688.000 CONTINUE
689.000 MC=NC+1
690.000 C OUTPUT MC,DNT
691.000 IF(MC.NE.2)GOTO 11
692.000 IF(R.LT.RM)GOTO 11
693.000 C OUTPUT R,RM
694.000 RM=R
695.000 DB=-DB
696.000 IF(IT.EQ.3) DMLP=-DMLP
697.000 GOTO 8
11 CONTINUE
698.000 IF(R.LT.RM) RM=R,GOTO 8
699.000 10 FORMAT(5F10.0)
700.000 20 FORMAT(F10.3,4E12.3)
701.000 29 FORMAT(5F10.0)
702.000 30 FORMAT(5F12.4)
703.000 40 FORMAT(5F10.0)
704.000 40 IT=IT+1

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795.000 IF(1T,10,1)WSP-WM,USP-USS,WUP-UUS
796.000 IF(1T,10,2)W1-WM,US1-USS,WU1-UUS
797.000 IF(1T,10,3)W2-WM,US2-USS,WU2-UUS
798.000 BP1-BP,DP,OUTPUT,BP1
799.000 IF(BP,LT,0.)BP=0.
800.000 7 BP-BP-DP
801.000 IF(1T,LT,4)GOTO 10
802.000 OUTPUT RP,RE,RLM
803.000 OUTPUT WSP,USE,USLM,WUP,WUE,WULM
804.000 USS-USP
805.000 WUS-WUP
806.000 IF(RP,LT,NE.AND,RP,LT,RLM)RETURN
807.000 USS-USE
808.000 WUS-WUE
809.000 IF(RE,LT,RLM)RETURN
810.000 USS-USLM
811.000 WUS-WULM
812.000 RETURN
813.000 END
814.000
815.000 C
816.000 C
817.000 C
818.000 C
819.000 C
820.000 C
821.000 C
822.000 C
823.000 C
824.000 C
825.000 C
826.000 C
827.000 C
828.000 C
829.000 C
830.000 C
831.000 C
832.000 C
833.000 C
834.000 C
835.000 C
836.000 C
837.000 C
838.000 C
839.000 C
840.000 C
841.000 C
842.000 C
843.000 C
844.000 C

```

FUNCTION YLIM(X,X,X,Y)
N - NUMBER OF DATA POINTS
X - X VALUE FOR WHICH Y VALUE MUST BE INTERPOLATED
X - DEPENDENT VARIABLE ARRAY
Y - INDEPENDENT VARIABLE ARRAY FOR WHICH
INTERPOLATIONS ARE PERFORMED
DIMENSION X(1),Y(1)
J=1
DO 10 1-J,N
IF (X-LT, X(1)) GO TO 11
CONTINUE
I=N
IF (X-GE, X(N)) GO TO 11
J=1
P=(X-X(J))/(X(1)-X(J))
IF (P-LT, 0. .OR. P-GE, 1.) P = 0.0
YLIM=Y(J) +P*(Y(1)-Y(J))
RETURN
END

APPENDIX B

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APR 22, '83 DC/ARIDJN.RILHRD

PROGRAM CFSTIM

BY R. JEFFREY KEELER
RON A. RICHTER
KARL B. YOUNG
SHANE C. MORRISON
DAVE KCHURCHILL

SWITCH FUNCTIONS

0	PLOT TIME SERIES
1	PLOT FFT
2	PLOT MAX ENTROPY-BURG
3	PLOT MAX ENTROPY-YULE/WALKER
4	PLOT ADAP-MAX ENTROPY
5	PLOT ADAP-WEIGHT TRANSFORM
6	PLOT ADAP-PREDICTED DATA TRANSFORM
7	PRINT COMPLEX COVARIANCE SPECTRUM MOMENTS
8	PLOT TRANSFORM OF MULTI-LAG COVARIANCE FUNCTION
9	PLOT AVERAGED FFT
10-12	SPARE
13	PLOT NEW FREQUENCY AXES
14	DO HISTOGRAMS
15	STOP PLOTTING

1	COMMON/PKS/PEAKS(3,1024,8)
	COMMON/SPEC/ ISPCFL(7),ISPC
	COMMON/SMR/RMS,SUMXI
	COMMON/LA/FLAGG
	COMMON/NEST,NAV,IEST,IWIDW,LORD,ALPHA,WGTS(128),ND
	COMMON/SW/ ISW(0:15)
	COMMON/SIGNL/ SIG(1024),RSLT(1024),WORK(1024),
	1NPTS,NPTS,NSTRT,NTOT,NDAT,PSIG,SNRF,SNR,
	2ISYNDAT,GSIG,GNOISE,FREQ,SIGMA
	COMMON/PLS/ XNORM(12),ICT,LOGSCL,FIRST,IPXFL
	COMMON/LRLS/LABEL(10,8)
	COMPLEX SIG,WGTS,R(129),SIGDAN(1024),SAVE(12)
	EQUIVALENCE (R(1),PSLT(1))
	LOGICAL FIRST,ISW
	EXTERNAL OVFINIT,OVINIT,OVPROC
	ISW(0)=.TRUE.

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```

51 - 51.000 ISW(1)=.FALSE.
52 - 52.000 ISW(2)=.FALSE.
53 - 53.000 ISW(3)=.FALSE.
54 - 54.000 ISW(4)=.FALSE.
55 - 55.000 ISW(5)=.FALSE.
56 - 56.000 ISW(6)=.FALSE.
57 - 57.000 ISW(7)=.FALSE.
58 - 58.000 ISW(8)=.FALSE.
59 - 59.000 ISW(9)=.FALSE.
60 - 60.000 ISW(10)=.FALSE.
61 - 61.000 ISW(11)=.FALSE.
62 - 62.000 ISW(12)=.FALSE.
63 - 63.000 ISW(13)=.FALSE.
64 - 64.000 ISW(14)=.FALSE.
65 - 65.000 ISW(15)=.FALSE.
66 - 66.000 C
67 - 67.000 C INITIALIZE PLOTTING PACKAGE)
68 - 68.000 C
69 - 69.000 CALL INITT(900)
70 - 70.000 C
71 - 71.000 C GET INPUT PARAMETERS
72 - 72.000 C
73 - 73.000 CALL INPUT
74 - 74.000 C
75 - 75.000 C
76 - 76.000 C INITIALIZE ARRAYS, OPEN FILES, ETC.
77 - 77.000 C
78 - 78.000 CALL INIT
79 - 79.000 C
80 - 80.000 C IF WE ARE EXAMINING AN OLD SPCMCN GO TO HISTOGRAM
81 - 81.000 C
82 - 82.000 IF (ISPC.EQ.1) GO TO 62
83 - 83.000 C
84 - 84.000 C GO THROUGH THE DIFFERENT ESTIMATORS NEST (NUMBER
85 - 85.000 C ESTIMATIONS) TIMES.
86 - 86.000 C
87 - 87.000 C NDATA2=NCAT
88 - 88.000 C NPTS2=NPTS
89 - 89.000 IS10=1
90 - 90.000 C FLAGG=0
91 - 91.000 C FIRST=.TRUE.
92 - 92.000 DO 129 IDAI=1,LORD
93 - 93.000 129 SAVE(IDAI)=WQTS(IDAI)
94 - 94.000 DO 10 IRLZ=IS10,NPTS
95 - 95.000 NSTRT=IRLZ
96 - 96.000 C
97 - 97.000 C
98 - 98.000 C GET DATA, AND STORE IT IN SIG
99 - 99.000 C
100 - 100.000 C NSEFD=0--INDICATES THIS IS FIRST TIME TH
101 - 101.000 C NOT A REFRESH
102 - 102.000 C

```

103 - 103.000 ININ=IRLZ ORIGINAL PAGE IS
104 - 104.000 NPTSF=NPTSF2 OF POOR QUALITY
105 - 105.000 CALL GETSIG (SIGPWR)
106 - 106.000 C
107 - 107.000 C
108 - 108.000 C PLOT COMPLEX TIME SERIES
109 - 109.000 C
110 - 110.000 DO 11 IDAI=1,2*NPTSF2
111 - 111.000 SIGDAN(IDAI)=SIG(IDAI)
112 - 112.000 11 CONTINUE
113 - 113.000 6 TXN=5.
114 - 114.000 IF (ISW(0)) CALL TINGRF (SIGPWR,TXN)
115 - 115.000 C
116 - 116.000 C NOW LET'S GO THROUGH THE DIFFERENT ESTIMATORS
117 - 117.000 C
118 - 118.000 DO 20 IST=1,8
119 - 119.000 C
120 - 120.000
121 - 121.000 C IF BIT IST IS NOT SET, ESTIMATOR IST WAS NOT REQUESTED
122 - 122.000 C
123 - 123.000 IF (.NOT.ISW(IST)) GO TO 20
124 - 124.000 C
125 - 125.000 C PERFORM THE ESTIMATION
126 - 126.000 C
127 - 127.000 GO TO (100,200,300,400,500,600,700,800) IST
128 - 128.000 C
129 - 129.000 C *****
130 - 130.000 C
131 - 131.000 C FAST FOURIER TRANSFORM
132 - 132.000 C
133 - 133.000 C THE FFT HAS SPECIAL PARAMETERS CONNECTED WITH IT WHICH
134 - 134.000 C ALLOWS IT TO DO AN FFT ON ALL INPUT POINTS (NTCT)
135 - 135.000 C EVEN IF THE FFT-SIZE (NPTS) FOR THE OTHER ESTIMATORS
136 - 136.000 C REQUESTED TO BE SMALLER
137 - 137.000 C
138 - 138.000 C
139 - 139.000 100 NDAT=64
140 - 140.000 NPTSF=NPTSF2
141 - 141.000 CALL SETFFT
142 - 142.000 C
143 - 143.000 C GFT POWER, FREQ, AND WIDTH OF SPECTRUM
144 - 144.000 C
145 - 145.000 CALL SPKPKR (IST,IRLZ)
146 - 146.000 C
147 - 147.000 C
148 - 148.000 C CHECK SWITCHES TO SEE IF YOU WANT A SPECTRUM PLOT
149 - 149.000 C
150 - 150.000 IF (FIRST) CALL PLSPEC (IST)
151 - 151.000 C
152 - 152.000 C
153 - 153.000 C UPDATE AVERAGE SPECTRUM
154 - 154.000 C

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55 - 155.000      CALL SPCAV ( 1ST,1RL2)
56 - 156.000 C
57 - 157.000 C      PLOT IF DESIRED
58 - 158.000 C
59 - 159.000      IF(1SW(9)) CALL PLSPEC ( 1ST)
60 - 160.000 C
61 - 161.000 C      END FFT--INPUT
62 - 162.000 C
63 - 163.000      GO TO 40
64 - 164.000 C *****
65 - 165.000 C
66 - 166.000 C
67 - 167.000 C      MAXIMUM ENTROPY--BURG ALGORITHM
68 - 168.000 C
69 - 169.000 C
70 - 170.000 200    CALL CBURG
71 - 171.000 C
72 - 172.000 C      THE REST OF THE BURG CALCULATION CAN BE DONE THE SAME
73 - 173.000 C      AS THE OTHER MAXIMUM ENTROPY ESTIMATORS
74 - 174.000 C
75 - 175.000      GO TO 30
76 - 176.000 C *****
77 - 177.000 C
78 - 178.000 C
79 - 179.000 C      MAXIMUM ENTROPY--YULE/WALKER ALGORITHM
80 - 180.000 C
81 - 181.000 C
82 - 182.000 C      GET CORRELATION COEFFICIENTS FIRST
83 - 183.000 C      (STORE IN RSLT)
84 - 184.000 C
85 - 185.000 300    CALL CCORR
86 - 186.000 C
87 - 187.000 C
88 - 188.000 C      THEN PROCESS THOSE COEFFICIENTS
89 - 189.000 C
90 - 190.000      CALL CLEV
91 - 191.000 C
92 - 192.000 C      THE REST OF THE YULE/WALKER CALCULATION CAN BE DONE
93 - 193.000 C      SAME AS THE OTHER MAX. ENTROPY ESTIMATORS
94 - 194.000 C
95 - 195.000      GO TO 30
96 - 196.000 C *****
97 - 197.000 C
98 - 198.000 C
99 - 199.000 C      MAXIMUM ENTROPY--ADAPTIVE FILTER ALGORITHM
100 - 200.000 C
101 - 201.000 C
102 - 202.000 400    CALL CALPF
103 - 203.000 C
104 - 204.000 C      SAVE THE PREDICTED OUTPUT IN "XC01"
105 - 205.000 C
106 - 206.000 C

```

ORIGINAL PAGE IS
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```
207.000 C      FROM HERE ON, 'TIS THE SAME FOR ALL MAX. ENTROPY
208.000 C      ESTIMATORS
209.000 C
210.000 30      CONTINUE
211.000 C
212.000      CALL MEMFFT
213.000 C
214.000 C      JOIN THE REST OF THE ESTIMATORS FOR PEAK-PICKING,
215.000 C      PLOTTING, ETC.
216.000 C
217.000      GO TO 50
218.000 C *****
219.000 C
220.000 C
221.000 C
222.000 C      ADAPTIVE FILTER--WEIGHTS
223.000 C
224.000 C
225.000 C      IF ALPF HAS ALREADY BEEN CALLED, THERE'S NO NEED TO DO
226.000 C      IT AGAIN...
227.000 C
228.000 500      IF(ISA(4)) GO TO 510
229.000      CALL CALPF
230.000 C
231.000 C      SAVE THE PREDICTED OUTPUT IN 'XCUT'
232.000 C
233.000 C
234.000 C      DO FOURIER ANALYSIS ON WEIGHTS
235.000 C
236.000      DO 510 IDAA=1,LORD
237.000 510      SIG(IDAA)=WGTS(IDAA)
238.000      NDAT=LORD
239.000      NPTSF=NPTS
240.000      DO 511 IDA=LORD+1,4*NPTSF
241.000 511      SIG(IDA)=0.
242.000      CALL SETFFT
243.000      FLAC=1.
244.000      GO TO 50
245.000 C *****
246.000 C
247.000 C
248.000 C      ADAPTIVE FILTER--PREDICTED
249.000 C
250.000 C      IF ALPF HAS ALREADY BEEN CALLED, THERE'S NO NEED TO DO
251.000 C      IT AGAIN....
252.000 C
253.000 600      NDAT=NDAT2
254.000      NPISF=NPTS
255.000      CALL CALPF
256.000      IF (ISA(12)) GOTO 800
257.000 C
258.000 C      DO FOURIER ANALYSIS ON PREDICTED OUTPUTS
```

ORIGINAL PAGE IS
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```

259.000 C
260.000 620 CALL SETFFT
261.000 C
262.000 C
263.000 C *****
264.000 C
265.000 C
266.000 C GET THE FIRST 3 MOMENTS OF SPECTRUM AND STORE THEM
267.000 C
268.000 50 CALL SPKPKP (IST,IRLZ)
269.000 C
270.000 C
271.000 C CHECK SWITCHES TO SEE IF YOU WANT A PLOT OF THE
272.000 C SPECTRUM
273.000 C
274.000 C IF (FIRST) CALL PLSPEC (IST)
275.000 C IF (FLAG.EQ.1) CALL PLSPEC(IST)
276.000 C FLAG=0.
277.000 C
278.000 40 CONTINUE
279.000 C
280.000 C RESTORE SIGNAL
281.000 C
282.000 C DO 41 ID11=1,2*NPTS2
283.000 C SIG(ID11)=SIGDAN(ID11)
284.000 41 CONTINUE
285.000 C DO 139 IDA1=1,LORD
286.000 139 WGT5(IDA1)=SAVE(IDA1)
287.000 C GO TO 20
288.000 C
289.000 C *****
290.000 C
291.000 C ROUTINES FOR COMPLEX COVARIANCE
292.000 C
293.000 C
294.000 C CALCULATE COMPLEX COVARIANCE
295.000 700 LORD11=1
296.000 CALL CCOVR
297.000 C
298.000 C CALL COMPLEX COVARIANCE ESTIMATOR
299.000 C
300.000 CALL CCOV (IST,IRLZ)
301.000 C
302.000 C PLOT POW,FREQ,AND VAR HERE
303.000 C
304.000 C IF (ISW(7)) OUTPUT IFP,ICT, CC*,RSLT(1),RSLT(2),RSLT(3)
305.000 C GO TO 20
306.000 C
307.000 C *****
308.000 C
309.000 C ROUTINE FOR MULTI-LAG COMPLEX COVARIANCE
310.000 C

```


ORIGINAL PAGE IS
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```

311.000 C          CALCULATE COMPLEX COVARIANCE FOR LORD LAGS
312.000 C
313.000 800      NDAT=NDAT2
314.000          CALL CCORR
315.000 C
316.000 C          GENERATE SYMMETRIC COVARIANCE FCT
317.000 C
318.000          LORDP=LORD+1
319.000          DO 805 I=1,LORDP
320.000          SIG(I)=R(I)
321.000 805      CONTINUE
322.000          N1 = LORD+2
323.000          N2 = NPTS - LORD
324.000          DO 810 I=N1,N2
325.000 810      SIG(I)=CMPLX(0.0,0.0)
326.000          DO 820 I=1,LORD
327.000          J=NPTS+1-I
328.000          SIG(J)=CONJG(R(I+1))
329.000 820      CONTINUE
330.000 C          DO FFT ON COVARIANCE FUNCTION
331.000 C
332.000          NDAT=NPTS
333.000          NPTSF=NPTS
334.000          CALL SF1FFT
335.000          GO TO 50
336.000 C
337.000 C          END-OF-LOOP      20
338.000 C
339.000 20      CONTINUE
340.000 C *****
341.000 C *****
342.000 C
343.000 C
344.000 C          END-OF-LOOP      10
345.000 C
346.000          IS*(1)=.FALSE.
347.000          FIRST=.FALSE.
348.000 10      CONTINUE
349.000 60      CALL BELL
350.000 C
351.000 C          HISTOGRAM PLOTTING SEQUENCE
352.000 C
353.000 C          1-READ IN RAW DATA          (DSKRD)
354.000 C          2-DO STATISTICS ON THEM      (STATS)
355.000 C          3-GET HISTOGRAM FROM THEM   (FHIST)
356.000 C          4-PLOT DATA AND HISTOGRAM  (HPLOT)
357.000 C
358.000 C
359.000 C          CHECK WHICH VARIABLE TO DO HISTOGRAMS OVER
360.000 C
361.000 C          CALL HDCOPY
362.000          CALL BELL

```



```

363.000      INPUT DANNY
364.000 62    CALL ERASE
365.000      CALL HOME
366.000      CALL ANMODE
367.000      OUTPUT "DO HISTOGRAMS FOR:"
368.000      OUTPUT "0-STCP"
369.000      OUTPUT "-1-RESTART"
370.000      OUTPUT "1-POWER"
371.000      OUTPUT "2-FREQUENCY"
372.000      OUTPUT "3-WIDTH"
373.000      INPUT IHIST
374.000      ISW(C)=.TRUE.
375.000      CALL ERASE
376.000      IF(IHIST.EQ.0)GOTO 9999
377.000      IF ((IHIST.EQ.0).AND.(ISPC.EQ.1)) GO TO 62
378.000      IF (IHIST.GT.3) GO TO 62
379.000      IF (IHIST.LT.0) GO TO 1
380.000 C
381.000 C      CYCLE THROUGH ALL HISTOGRAMS
382.000 C
383.000      DO 70 IST=1,8
384.000 C
385.000 C
386.000 C      IF WE DIDN'T USE THIS ESTIMATION
387.000 C      GOING TO DO A HISTOGRAM ON IT.
388.000 C
389.000      IF(.NOT.(ISW(IST))) GO TO 70
390.000 C
391.000 C      1-READ IN DATA
392.000 C
393.000      CALL DSKRD (IST,IHIST)
394.000 C
395.000 C      3-GET HISTOGRAM FROM THEM
396.000 C
397.000 C      (NOTE: THE FFT MAY HAVE A DIFFERENT NUMBER
398.000 C      OF POINTS TO DO A HISTOGRAM OVER)
399.000 C
400.000      NBINS=NPTS
401.000      IF (IST.EQ.1) NBINS=NPTSF
402.000      IF(IHIST.NE.2) NBINS=100
403.000      CALL EHIST (HMAX,NBINS,IHIST)
404.000 C
405.000 C      2-DO STATISTICS ON THEM
406.000 C
407.000      CALL STATS ( XMEAN,STDEV,NBINS)
408.000 C
409.000 C      4-PLOT DATA HISTOGRAM
410.000 C
411.000      DO 75 I=1,NEST
412.000      SIG(I)=CMPLX(WORK(I),0.0)
413.000 75    CONTINUE
414.000 C

```

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```

415.000 CALL HPLOT (HMAX,XMEAN,STDEV,NBINS,IHIST,IST)
416.000 C
417.000 70 CONTINUE
418.000 GO TO 62
419.000 9999 STOP
420.000 END
421.000 C
422.000 C ORIGINAL PAGE IS
423.000 C OF POOR QUALITY
424.000 C
425.000 C
426.000 C
427.000 SUBROUTINE INPUT
428.000 C
429.000 C
430.000 C *****
431.000 C
432.000 C ROUTINE TO INPUT FROM KEYBOARD EVERYTHING IT
433.000 C DOESN'T KNOW
434.000 C
435.000 C
436.000 C *****
437.000 C
438.000 COMMON/SPEC/ISPCFL(7),ISPC
439.000 COMMON/TEST,IAV,TEST,IWNDW,LORD,ALPHA,WCTS(128),NO
440.000 COMMON /SW/ ISW(0:15)
441.000 COMMON/SIGNL/ SIG(1024),RSLT(1024),WORK(1024),
442.000 1NFTSF,NPTS,ASTRT,NTOT,NDAT,PSIG,SNRF,SNR,
443.000 2ISYNDAT,GSIC,GNOISE,FREQ,SIGMA
444.000 COMMON/PLS/ XNORM(10),ICT,LOGSCL,FIRST,IPXFL,LNAME(4),LPL
445.000 COMMON/LHLS/LABEL(20,8)
446.000 COMPLEX SIG,WCTS
447.000 LOGICAL FIRST,ISW
448.000 DIMENSION MIFILE(4),IHEAD(256),IDT(3),ITM(3)
449.000 DATA ((LABEL(I,J),I=1,10),J=1,8)/'FAST','FOU','RIER',
450.000 1'TRA','NSFC','RM','4*',
451.000 1'MAXI','MUM','ENTR','OPY-','-BUR','GAL','GORI','THM',
452.000 12*',
453.000 1'MAXI','MUM','ENTR','OPY-','-VUL','E/WA','LKER',
454.000 1'ALG','ORI1','HM',
455.000 1'MAXI','MUM','ENTR','OPY-','-ADA','PTIV','E-FI','LTER',
456.000 1'ALG','RTHM',
457.000 1'ADAP','TIVE','FIL','TER-','-WEI','GHTS','4*',
458.000 1'ADAP','TIVE','FIL','TER-','-PRE','DICT','ED','3*',
459.000 1'COMP','LEX','COVA','RIAN','CE','5*',
460.000 1'MULT','I-LA','G CO','MPLE','X CO','VARI','ANCE','3*',
461.000 EQUIVALENCE (IHEAD(1),WORK(1))
462.000 TEST=0
463.000 C
464.000 C GET SOME INFORMATION ON THE INPUT DATA
465.000 C
466.000 CALL ANMODE

```

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```

467.000      ISPC=0
468.000 C
469.000 C      NBRP-NARROW BAND RAYLEIGH PROCESS
470.000 C      DO WE WANT SINUSOIDAL OR NBRP OUTPUT OF SYNTHETIC
471.000 C
472.000 20      OUTPUT 'SINUSOIDAL(1) OR NBRP(2) SYNTHETIC DATA;'
473.000      INPUT ISYNDAT
474.000      OUTPUT ISYNDAT
475.000 C
476.000 C      GIVE THEM A CHOICE OF ESTIMATORS
477.000 C
478.000 40      CALL MOVABS (C,C50)
479.000      OUTPUT 'THE FOLLOWING ESTIMATORS ARE AVAILABLE SINGLY OR'
480.000      OUTPUT 'SIMULTANEOUSLY.'
481.000      OUTPUT 'INPUT A 1 IF YOU WANT THE INDICATED ESTIMATOR, 0 IF NOT'
482.000      OUTPUT ' '
483.000      DO 100 I=1,6
484.000      WRITE(10,1000) (LABEL(J,I),J=1,10)
485.000 1000    FORMAT(FOA4)
486.000 100    CONTINUE
487.000 C
488.000 C      NOW REPRINT NAME OF ESTIMATOR AND ACCEPT A 1 OR 0 AFTER
489.000 C      IT
490.000 C
491.000      DO 200 I=1,6
492.000      WRITE (10,1020) (LABEL(J,I),J=1,10)
493.000 1020    FORMAT (20A4,2)
494.000 199      INPUT ISI
495.000      OUTPUT ' '
496.000      IF (ISI.EQ. 1) ISW(I) = .TRUE.
497.000 200    CONTINUE
498.000 C
499.000 C      EST 6 -- ADAPTIVE (FOURIER TRANSFORM) PREDICTED
500.000 C      IF ESTIMATOR 6 WAS SPECIFIED, WE NEED TO KNOW HOW
501.000 C      MANY OUTPUT DATA POINTS WE WANT TO
502.000 C      GET FROM THE ADAPTIVE FILTER
503.000 C
504.000      IF (.NOT.ISW(6)) GO TO 300
505.000      OUTPUT 'DO YOU WANT TO ENTER MULTI-LAG FROM ALPFI-YES,0-NO'
506.000      INPUT MDAN
507.000      IF (MDAN.EQ.1)ISW(12)=.TRUE.
508.000      OUTPUT '**NUMBER OF ALPF PREDICTION SAMPLES TO USE'
509.000      INPUT NDAT
510.000      OUTPUT NDAT
511.000 C
512.000 C      IF MAX ENTROPY ESTIMATORS WERE SPECIFIED, WE ASK FOR
513.000 C      THEIR ORDER...
514.000 C
515.000 300      OUTPUT ' '
516.000      LCRD=-1
517.000      IF (.NOT.(ISW(2).OR.ISW(3))) GO TO 310
518.000      OUTPUT 'ORDER OF MAXIMUM ENTROPY ESTIMATORS'

```

ORIGINAL PAGE IS
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```

519.000 INPUT LORD
520.000 OUTPUT LORD
521.000 GO TO 320
522.000 C
523.000 C IF MAX ENTROPY NOT SPECIFIED, BUT ADAPTIVE IS, THEN
524.000 C WE ASK FOR THEIR ORDER (IT'S THE SAME THING)
525.000 C
526.000 310 IF (.NOT.(ISW(4).OR.ISW(5).OR.ISW(6))) GO TO 340
527.000 OUTPUT "ORDER OF ADAPTIVE FILTER"
528.000 INPUT LORD
529.000 OUTPUT LORD
530.000 GO TO 330
531.000 C
532.000 C IF ADAPTIVE IS SPECIFIED, WE NEED SOME OTHER NEAT
533.000 C PARAMETERS
534.000 C
535.000 320 IF(.NOT.(ISW(4).OR.ISW(5).OR.ISW(6))) GO TO 340
536.000 330 OUTPUT "NORMALIZED ADAPTIVE CONSTANT (ALPHA)"
537.000 INPUT ALPHA
538.000 OUTPUT ALPHA
539.000 C
540.000 C IF MAX ENTROPY OR ADAPTIVE ESTIMATORS NOT
541.000 C SPECIFIED AND IF MULTI-LAG COMPLEX COVARIANCE
542.000 C IS SPECIFIED, THEN GET NUMBER OF LAGS (ORDER)
543.000 C
544.000 340 IF (LORD .EQ. -1 .AND. ISW(6)) GO TO 341
545.000 GO TO 342
546.000 341 OUTPUT "ORDER OF MULTI-LAG COMPLEX COVARIANCE ESTIMATOR"
547.000 INPUT LORD
548.000 OUTPUT LORD
549.000 C
550.000 C IF SYNTHETIC DATA, WE NEED TO KNOW WHAT FREQUENCY, ETC
551.000 C
552.000 342 IF (ISYNDAT.EQ.0) GO TO 350
553.000 OUTPUT "FREQUENCY OF SYNTHETIC DATA"
554.000 INPUT FREQ
555.000 OUTPUT FREQ
556.000 C
557.000 C AND IF IT'S NBRP DATA, WE NEED A WIDTH...
558.000 C
559.000 IF (ISYNDAT .EQ. 2) GO TO 2323
560.000 343 OUTPUT "SNR OF SYNTHETIC DATA (DB)"
561.000 INPUT SNR
562.000 OUTPUT SNR
563.000 GO TO 360
564.000 2323 OUTPUT "STANDARD DEVIATION OF SIGNAL"
565.000 INPUT SIGMA
566.000 OUTPUT SIGMA
567.000 GO TO 343
568.000 C
569.000 C BUT IF ACTUAL DATA, WE NEED SOME OTHER PARAMETERS...
570.000 C

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571.000 350  OUTPUT 'ESTIMATED WIDE-BAND SNR OF DATA (DB)',SNR
572.000 C
573.000 C      GET INFORMATION ABOUT FFT PROCESSING
574.000 C
575.000 360  NSTFT=1
576.000 362  IF (NSTFT .LT. 1) GO TO 360
577.000  OUTPUT 'TOTAL NUMBER OF INPUT DATA POINTS'
578.000  INPUT NTOT
579.000  OUTPUT NTOT
580.000  ISPCPLT=0
581.000  IF (ISW(1).CR.ISW(2).OR.ISW(3).CR.ISW(4).CR.ISW(5).CR.ISW(6)
582.000  +.CR.ISW(8)) ISPCPLT=1
583.000  IF (ISPCPLT .EQ. 1) GO TO 367
584.000  GO TO 369
585.000 367  OUTPUT 'LENGTH OF TRANSFORM FOR SPECTRUM (POWER OF 2)'
586.000  INPUT NPTS
587.000  OUTPUT NPTS
588.000 C
589.000 C      CHECK IF IT'S APPROPRIATE TO ASK ABOUT WINDOWING
590.000 C      (IF IT IS, DO IT)
591.000 C
592.000 369  IF (ISW(1).OR.ISW(5).OR.ISW(6)) GO TO 391
593.000  GO TO 392
594.000 391  OUTPUT 'WINDOWING FOR FOURIER TRANSFORMS (1/0)'
595.000  INPUT IANDW
596.000  OUTPUT IANDW
597.000 C
598.000 C      AND, LAST BUT NOT LEAST...
599.000 C
600.000 392  IF (ISW(1)) GO TO 393
601.000  GO TO 394
602.000 393  OUTPUT 'FFT AVERAGING TIME CONSTANT'
603.000  INPUT NAV
604.000  OUTPUT NAV
605.000 394  IF (NAV.LE.0) NAV=1
606.000  OUTPUT 'NUMBER OF ESTIMATES'
607.000  INPUT NEST
608.000  OUTPUT NEST
609.000  IF (NEST.GT.1000) NEST=1000
610.000  IF (ISPCPLT .EQ. 1) GO TO 395
611.000  GO TO 396
612.000 395  OUTPUT 'SPECTRUM PLOTS: LINEAR (0) OR LOG(1)'
613.000  INPUT LOGSCL
614.000  OUTPUT LOGSCL
615.000 396  IF (.NOT.ISW(6)) NDAT=64
616.000 C      OUTPUT 'INPUT WGTS(1)'
617.000 C      INPUT WGTS(1)
618.000 C      OUTPUT 'INPUT WGTS(2)'
619.000 C      INPUT WGTS(2)
620.000 C      OUTPUT 'INPUT WGTS(3)'
621.000 C      INPUT WGTS(3)
622.000 C      OUTPUT 'INPUT WGTS(4)'

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623.000 C      INPUT WCTS(4)
624.000      OUTPUT 'DO YOU WANT HDCOPY 1=YES,0=NO'
625.000      INPUT HDANS
626.000      IF (HDANS.EQ.1)CALL HDCOPY
627.000      CALL FRASE
628.000      RETURN
629.000      END
630.000 C
631.000 C
632.000 C
633.000 C
634.000      SUBROUTINE INIT
635.000 C
636.000 C *****
637.000 C
638.000 C      THE GRAND INITIALIZING ROUTINE
639.000 C
640.000 C
641.000 C *****
642.000 C
643.000      COMMON/SPEC/ ISPCFL(7),ISPC
644.000      COMMON/INITIAL/ IRP,IFP,MTFOP
645.000      COMMON/NEST,NAV,IEST,IWVDW,LORD,ALPHA,WCTS(128),NO
646.000      COMMON/SIGNAL/ SIG(1024),PSLT(1024),WORK(1024),
647.000      1NPTSE,NPTS,NSTFT,NTOT,NDAT,PSIG,SNRF,SNR,
648.000      2ISYNDAT,GSIG,GNOISE,FREQ,SIGMA
649.000      COMMON/PLS/ XNORM(10),ICT,LOGSCL,FIRST,IPXFL,LNAME(4),LPL
650.000      COMMON/LBLS/LABEL(20,8)
651.000      LOGICAL FIRST,LPL
652.000      COMPLEX SIG,WCTS
653.000      DIMENSION DATUMS(2048)
654.000      DIMENSION IDAT(1024)
655.000      EQUIVALENCE (DATUMS(1),SIG(1))
656.000      DO 100 I=1,600
657.000 100      WORK(I)=0.
658.000 C
659.000 C
660.000 C      SYNTHETIC DATA (NBRF) DOES'NT NEED ANYTHING DONE FOR IT
661.000 C
662.000 C      NORMALIZE MULTIPLICATION FACTORS FOR SNR
663.000 C      TOTAL INPUT POWER (VARIANCE) IS UNITY
664.000 C
665.000 500      SNRF=10.**(SNR/10.)
666.000      PNOISE=1./(1.+SNRF)
667.000      PSIG=1.-PNOISE
668.000      CNOISE=SQRT(PNOISE/2.)
669.000      GSIG=SQRT(PSIG)
670.000 C
671.000 C      GET NUMBER OF TRAINING POINTS (NO) FOR ALPF
672.000 C
673.000 C      NO=NTOT-NDAT
674.000 C

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675.000 C      GET PARAMETERS FOR INPUT-FFT
676.000 C
677.000      NPTS=NPTS
678.000 C      IF(NPTS.GE.NTOT) GO TO 600
679.000 C      M=ALOG(FLOAT(NTOT)-1.)/ALOG(2.)+1.
680.000 C      NPTS=2**M
681.000 C
682.000 C      SET PARAMETERS FOR PLSPEC
683.000 C
684.000 600      FIRST=.TRUE.
685.000      IPXFL=0
686.000 C
687.000      XNORM(1)=PSIG*NTOT + PNOISE
688.000 C
689.000      XNORM(2)=(SNRF*LORD + 1.) ** 2
690.000 C
691.000      XNORM(3)=XNORM(2)
692.000 C
693.000      XNORM(4)=XNORM(2)
694.000 C
695.000      XF=1./LORD + 1./SNRF
696.000 C      MAGN OF ALPF WEIGHT VECTOR
697.000      PX=XK*XK
698.000      XNORM(5)=PX*LORD
699.000 C
700.000      FX=(XK*LORD)**2 * PSIG
701.000 C      ALPF GAIN**2 * PSIG
702.000      XNORM(6)=PX*NDAT
703.000 C
704.000      XNORM(7)=1.
705.000      XNORM(8)=XNORM(1)
706.000      XNORM(9)=1.
707.000      XNORM(10)=1.
708.000 C
709.000      RETURN
710.000      END
711.000 C
712.000 C
713.000 C
714.000      SUBROUTINE GETSIG (SIGPWR)
715.000 C
716.000 C      SUBROUTINE TO GET THE APPROPRIATE SIGNAL TO BE PROCESSED
717.000 C
718.000 C *****
719.000 C
720.000 C
721.000 C      THERE ARE THREE DIFFERENT OUTPUTS OF SIGNALS:
722.000 C
723.000 C
724.000 C      SYNTHETIC/SINUSOIDAL--WITH RANDOM NOISE
725.000 C      (ISYNDAT=1)
726.000 C

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727.000 C      SYNTHETIC/NBRP--NARROW-BAND RANDOM PROCESS
728.000 C      WITH RANDOM NOISE
729.000 C      (ISYNDAT=2)
730.000 C
731.000 C      NSEED=0 => GENERATE NEW DATA
732.000 C
733.000 C
734.000 C *****
735.000 C
736.000 C
737.000 C      COMMON BLOCK WITH SIGNAL PARAMETERS
738.000 C
739.000 C
740.000      COMMON/SNR/RMS,SUMX1
741.000      COMMON/PLS/XNORM(10),ICT,LOGSCL,IPXFL,NAME(4),LPL
742.000      COMMON/KEST,NAV,IEST,IWNDW,LOPD,ALPHA,WGTS(128),NO
743.000      COMMON /SIGNAL/ SIG(1024),PSLT(1024),WCFK(1024),
744.000      IMPTSF,MPTS,ASTRT,NTOT,NDAT,PSIG,SNRF,SNR,
745.000      2ISYNDAT,GSIG,GNOISE,FREQ,SIGMA
746.000      COMPLEX SIG,WGTS,CSCAL
747.000      INTEGER KBYTE
748.000      DIMENSION DATUMS(2048),IDAT(1024),RAN(1)
749.000      EQUIVALENCE (DATUMS(1),SIG(1))
750.000      LOGICAL FIRST
751.000      DATA NSEED/0/
752.000      IF(NSEED.EQ.0)CALL RNDU(RAN,NSEED)
753.000 C
754.000 C      GO TO APPROPRIATE ROUTINE
755.000 C
756.000      IS=ISYNDAT+1
757.000      GO TO (2000,2000,3000) IS
758.000 C
759.000 C
760.000 C *****
761.000 C
762.000 C      SYNTHETIC DATA
763.000 C      (SINUSOIDAL)
764.000 C
765.000 C      GET SINE WAVE FROM DISK
766.000 C      (INIT HAS PLACED COSINE IN REAL PART, SINE IN
767.000 C      IMAGINARY PART)
768.000 C
769.000 C      SYNTHETIC DATA (SINUSOIDAL) NEEDS A SINE WAVE IN "SINE"
770.000 C      (REAL=COSINE, IMAGINARY=SINE)
771.000 C
772.000 2000      OUTPUT **
773.000      IF (FREQ)401,402,402
774.000 401      FREQ=FREQ+1.
775.000 402      W=6.28318508*FREQ
776.000      DO 410 I=1,NPTSF
777.000      THETA=W*FLOAT(I-1)
778.000      SIG(I)=CMPLX(COS(THETA),SIN(THETA))

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779.000 C IF(SIG(I).EQ.0.0)OUTPUT I,THETA
780.000 410 CONTINUE
781.000 TX0=2.0
782.000 FIRST=.TRUE.
783.000 SIGPAR=1.
784.000 ONE=1.
785.000 IST=1
786.000 M=7
787.000 C
788.000 C ADD RANDOM NOISE TO EACH PART
789.000 C
790.000 N10T2=NPTSF*2
791.000 DO 2300 I=1,N10T2,2
792.000 LATUMS(I)=LATUMS(I)*GSIG+DFAN(LUM)*GNOISE
793.000 2300 DATUMS(I+1)=DATUMS(I+1)*GSIG+DFAN(DUM)*GNOISE
794.000 SIGPAR=1.
795.000 GO TO 4000
796.000 C
797.000 C
798.000 C
799.000 C
800.000 C SYNTHETIC DATA
801.000 C (NARROW-BAND RANDOM PROCESS)
802.000 C
803.000 C
804.000 C GENERATE SIGNAL SPECTRUM AND SIGNAL POWER
805.000 C USING FREQUENCY AT MIDPOINT (.5)
806.000 C
807.000 3000 PJ=3.14159265359
808.000 C=1./((SIGMA*SQRT(2.*PI)))
809.000 SIG2=2.*SIGPAR*SIGMA
810.000 PSIG=0.
811.000 DO 3210 I=1,NPTSF
812.000 DFREQ=FLOAT(I-1)/FLOAT(NPTSF)-.5
813.000 RSLT(I)=0
814.000 IF (ABS(DFREQ).LT.(5.*SIGMA)) RSLT(I)=C*EXP(-(DFREQ*DFREQ)/SIG2)
815.000 3210 PSIG=PSIG+RSLT(I)
816.000 C
817.000 C CALCULATE NOISE POWER
818.000 C
819.000 PNOISE=PSIG/SNRF
820.000 C
821.000 C NORMALIZE TO UNIT TOTAL POWER
822.000 C
823.000 PSUM=PSIG+PNOISE
824.000 PSIG=PSIG/PSUM
825.000 PNOISE=PNOISE/PSUM
826.000 SIGPAR=1.0
827.000 C
828.000 C RANDOMIZE TO EXPONENTIAL DISTRIBUTION
829.000 C
830.000 SCA=1./FLOAT(NPTSF)

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831.000      DO 3220 I=1,NPTSF
832.000      NSEED=1
833.000      CALL PNDU(FAN,NSEED)
834.000 3220 RSL1(I)=-ALCG(RAN(1))*SCA*(PSIG*RSL1(1)+FNOISE)
835.000 C
836.000 C      GENERATE COMPLEX SPECTRUM FOR INPUT TO INVERSE FFT
837.000 C      SHIFTING SPECTUM OVER SO THAT CENTER FREQUENCY IS
838.000 C      OVER SPECIFIED FREQUENCY (FREQ) AND "TAILS" OF
839.000 C      THE SPECTRUM ARE CYCLIC
840.000 C
841.000 3221      CONTINUE
842.000      FREQ2=FREQ
843.000      IF (FREQ.LT.0.) FREQ2=FREQ+1.
844.000      NL=IFIX(FREQ2*NPTSF)-NPTSF/2+NPTSF*2
845.000      AVG=0.
846.000      DO 3230 I=1,NPTSF
847.000      ID=MOD((I+NL),NPTSF)+1
848.000      INDXI=2*ID
849.000      INDXR=INDXI-1
850.000      XR=SQRT(RSL1(I))*1
851.000      NSEED=1
852.000      CALL PNDU(FAN,NSEED)
853.000      ARGUM=2.*PI*RAN(1)
854.000      DATUMS(INDXR)=XR*COS(ARGUM)
855.000 3230 DATUMS(INDXI)=XR*SIN(ARGUM)
856.000      AVG=AVG/NPTSF
857.000 C      OUTPUT AVG
858.000 C
859.000 C      GENERATE COMPLEX TIME SERIES FROM INVERSE FFT
860.000 C
861.000      P=ALCG(FLOAT(NPTSF))/ALOG(2.)*.5
862.000      ONE1=-1.
863.000      CALL FFT (M,CN=1)
864.000      SCAL=FLOAT(NPTSF)
865.000      CSCAL=CMPLX(SCAL,0.)
866.000      SUMXI=0.
867.000      DO 3233 NDAN=1,2*NPTSF
868.000      SIG(NDAN)=CSCAL*SIG(NDAN)
869.000 3233 SUMXI=CABS(SIG(NDAN))*2+SUMXI
870.000      RMS=SQRT(SUMXI/(NPTSF*2))
871.000      SCAL=1/RMS
872.000      CSCAL=CMPLX(SCAL,0.)
873.000      SUMXI=0.
874.000      DO 3234 NDAN=1,2*NPTSF
875.000      SIG(NDAN)=CSCAL*SIG(NDAN)
876.000 3234 SUMXI=SUMXI+CABS(SIG(NDAN))*2
877.000      RMS=SQRT(SUMXI/(NPTSF*2))
878.000 C      NPTSF=64
879.000 4000 RETURN
880.000      END
881.000 C
882.000 C

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883.000 C
884.000 SUBROUTINE TINGRF (SIGWR, SCL)
885.000 C
886.000 COMMON/PLS/XNCRM(10), ICT, LOGSCL, FIRST, IFXFL
887.000 COMMON/SIGL/SIG(1024), RSLT(1024), WORK(1024),
888.000 INPTSF, NPTS, NSTRT, NTOT, NDAT, PSIG, SNRF, SNR,
889.000 2ISYNDAT, GSIG, GNOISE, FREQ, SIGMA
890.000 COMMON /SW/ ISW(0:15)
891.000 COMMON/SMR/RMS, SUMX!
892.000 DIMENSION ICT(3), ITM(3)
893.000 COMPLEX SIG, WGTB
894.000 LOGICAL FIRST, ISW
895.000 1 XMIN = 0.
896.000 XMAX = FLOAT(NPTS)
897.000 YMIN = -SCL
898.000 YMAX = SCL
899.000 C IF (.NOT. ISW(0)) RETURN
900.000 CALL ERASE
901.000 DO 100 IC=1,2
902.000 C
903.000 C IF IC = 1 PLOT REAL DATA. IF IC = 2 PLOT COMPLEX DATA
904.000 C
905.000 CALL TWINDO(50,960,410,760)
906.000 IF (IC.EQ.2) CALL TWINDJ(50,960,60,410)
907.000 CALL DWINDU (XMIN,XMAX,YMIN,YMAX)
908.000 C
909.000 C DRAW AXIS AND TIC MARKS
910.000 C
911.000 CALL MOVEA (XMIN,YMIN)
912.000 CALL DRAWA (XMIN,YMAX)
913.000 CALL MOVEA (0.,0.)
914.000 CALL DRAWA (XMAX,0.)
915.000 C
916.000 CALL MOVEA (XMIN,YMIN)
917.000 CALL SEFLOC (IX,IY)
918.000 CALL DRWABS (IX+30,IY)
919.000 C
920.000 C DRAW TICS
921.000 C
922.000 NY = 10
923.000 YY = 0.
924.000 NYPI = NY + 1
925.000 YINC = (YMAX - 0.)/NY
926.000 DO 20 J=1,NYPI
927.000 CALL MOVEA (0.,YY)
928.000 CALL SEFLOC (IX,IY)
929.000 CALL DRWABS (IX+15,IY)
930.000 20 YY = YY + YINC
931.000 YY = 0.
932.000 YINC = (0. - YMIN)/NY
933.000 DO 30 K=1,NYPI
934.000 CALL MOVEA (0.,YY)

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935.000      CALL SEFLOC (IX,IV)
936.000      CALL DRWABS (IX+15,IV)
937.000 30    VY = VY - VINC
938.000 C
939.000      Y = REAL(SIG(1))
940.000      IF (IC.EQ.2) Y = AIMAG(SIG(1))
941.000      X = 0.
942.000      CALL MOVEA (X,Y)
943.000      DO 40 I=2,NPTS
944.000      X = FLOAT (I-1)
945.000      Y = REAL(SIG(I))
946.000      IF (IC.EQ.2) Y=AIMAG(SIG(I))
947.000 40    CALL DRAWA (X,Y)
948.000 100   CONTINUE
949.000 C
950.000 C      LABEL GRAPH
951.000 C
952.000      CALL MOVABS (100,750)
953.000      CALL ANMODE
954.000      OUTPUT 'REAL'
955.000      CALL RICOVR
956.000      CALL MOVABS (100,400)
957.000      CALL ANMODE
958.000      OUTPUT 'IMAGINARY'
959.000      CALL RICOVR
960.000      CALL MOVABS (100,60)
961.000      CALL ANMODE
962.000      SIGRMS=SQRT(SIGPWR)
963.000      OUTPUT 'RMS SIGNAL LEVEL = ',RMS,' NO. POINTS = ',NPTS
964.000      FIRST=.TRUE.
965.000      ISW(0)=.FALSE.
966.000      OUTPUT 'HARD COPY 1=YES,0=NO;'
967.000      INPUT HDAN
968.000      IF(HDAN.EQ.1)CALL HDCOPY
969.000      CALL ERASE
970.000      RETURN
971.000      END
972.000 C
973.000 C
974.000 C
975.000      SUBROUTINE SETFFT
976.000 C
977.000 C *****
978.000 C
979.000 C      ROUTINE TO SET UP FOR FFT, WINDOW INPUT ARRAY, AND STORE
980.000 C      RESULT IN RSLT
981.000 C
982.000 C      SIG      INPUT SIGNAL
983.000 C      NPTS     NUMBER OF POINTS IN TRANSFORM
984.000 C      NDATA   NUMBER OF NON-ZERO DATA POINTS
985.000 C      IWINLW  WINDOWING FLAG (IF = 1= THEN WINDOW)
986.000 C      RSLT    ARRAY TO HOLD RESULT

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937.000 C
938.000 C *****
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COMMON/SIGNL/SIG(1024),RSLT(1024),WCRK(1024),
 1NPTSF,NPTS,ASTRT,NTUT,NDAT,PSIG,SNRF,SNR,
 21SYNDAT,GSIC,GNOISE,FREQ,SIGMA
 COMMON NEST,NAV,TEST,IWNDW,LORD,ALPHA,WCTS(126),NO
 COMMON/SW/ISW(0:15)
 LOGICAL FIRST,ISW
 COMPLEX SIG,WCTS
 FIGURE OUT 2**M=NPTS
 M=ALOG(FLOAT(NPTSF))/ALOG(2.)+.5
 DO WE WANT WINDOWING ((IWNDW=1, YES)
 IWDC=IWNDW
 IF (ISW(8)) GOTO 1091
 GOTO 1092
 1091 IWDC=0
 1092 IF (IWDC.NE.1) GO TO 100
 YES
 FIGURE OUT INCREMENT FOR THETA BETWEEN EACH
 ELEMENT IN ARRAY
 WFAC=(2.*3.14159265359)/FLOAT(NDAT+1)
 PROCESS ENTIRE ARRAY THROUGH HANNING WINDOW
 (INCREMENTING ARGUMENT TO COSINE (THETA) BY
 WFAC EACH TIME)
 THETA=0.
 DO 10 I=1,NDAT
 THETA=THETA+WFAC
 SIG(I)=SIG(I)*.5*(1.-COS(THETA))
 IF (SIG(I).EQ.0.0) OUTPUT SIG(I),THETA,WFAC
 10 CONTINUE
 FILL OUT WITH ZEROES IF NDAT<NPTS
 NDAT1=NDAT+1
 DO 110 I=NDAT1,NPTSF
 SIG(I)=(0.,0.)
 DO FFT ON SIGNAL
 CME = 1.

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1039.000      CALL FFT (M,ONE)
1040.000 C
1041.000 C      PLACE POWER SPECTRUM INTO RESULT
1042.000 C
1043.000      DO 200 I=1,NPTSF
1044.000      RSLT(I)=CABS(SIG(I))**2/FLOAT(NDAT)
1045.000 C      IF(RSLT(I).EQ.0.0) OUTPUT I,SIG(I),NDAT,RSLT(I)
1046.000 200      CONTINUE
1047.000      RETURN
1048.000      END

1102.000 C
1103.000 C
1104.000 C
1105.000      SUBROUTINE CALPF
1106.000 C      ALPF (ADAPTIVE LINEAR PREDICTION FILTER)
1107.000 C      ARRAY X IS USED TO UPDATE COEFFICIENT VECTOR G ACCORDING TO THE
1108.000 C      LMS (NOISY GRADIENT) ADAPTIVE ALGORITHM
1109.000 C      FILTER IS FILLED BEFORE ADAPTION BEGINS
1110.000 C
1111.000      COMMON/LA/FLAGG
1112.000      COMMON/SIGNL/SIG(1024),RSLT(1024),WORK(1024),
1113.000      1NPTSF,NPTS,NSHT,NTOT,NDAT,PSIG,SNRF,SNR,
1114.000      2ISYNDAT,CSIG,CNOISE,FREQ,SIGMA
1115.000      COMMON NEST,NAV,TEST,LWNDW,LORD,ALPHA,WCTS(128),NO
1116.000      COMPLEX SIG ,WCTS ,XOUTT,ER,EROR
1117.000      XMU=ALPHA/FLOAT(LORD)
1118.000      DO 1 I=1,LORD
1119.000 1      WCTS(I)=0.
1120.000      LORDP=LORD+1
1121.000 C
1122.000 C      DO TRAINING
1123.000 C
1124.000      DO 100 K=LORDP, 448
1125.000      XOUTT=(0.,0.)
1126.000 C
1127.000 C      FILTER TO GET KTH OUTPUT
1128.000 C
1129.000      DO 10 L=1,LORD
1130.000      KK=K-L
1131.000      XOUTT=XOUTT+WCTS(L)*SIG(KK)
1132.000 10      CONTINUE
1133.000 C
1134.000 C      ADAPT WEIGHTS
1135.000 C
1136.000      ER=SIG(K)-XOUTT
1137.000      EROR=ER*XMU
1138.000      DO 20 L=1,LORD
1139.000      KK=K-L
1140.000      WCTS(L)=WCTS(L)+EROR*CONJG(SIG(KK))
1141.000 20      CONTINUE
1142.000 100      CONTINUE

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1143.000 101 NOP=N0+1
1144.000 C
1145.000 C TRAINING OVER, SAVE OUTPUT
1146.000 C
1147.000 DC 200 K=449,512
1148.000 XCUTT=(0.,0.)
1149.000 C
1150.000 C FILTER TO GET KTH OUTPUT
1151.000 C
1152.000 DC 210 L=1,LORD
1153.000 KK=K-L
1154.000 XCUTT=XCUTT+WCTS(L)*SIG(KK)
1155.000 210 CONTINUE
1156.000 C
1157.000 C ADAPT WEIGHTS
1158.000 C
1159.000 EF=SIG(K)-XCUTT
1160.000 EFOP=EF*XMU
1161.000 DC 220 L=1,LCAD
1162.000 KK=K-L
1163.000 WCTS(L)=WCTS(L)+ERROR*CONJG(SIG(KK))
1164.000 C OUTPUT L,WCTS(L)
1165.000 220 CONTINUE
1166.000 C EMS=EMS+CAHS(ER)
1167.000 SIG(K-449)=XCUTT
1168.000 200 CONTINUE
1169.000 C IF (NTOT.NE.N0) EMS=EMS/(NTOT-N0)
1170.000 RETURN
1171.000 END
```

```

1309.000 C
1310.000 C
1311.000 C
1312.000 SUBROUTINE CCORR
1313.000 C
1314.000 C .....
1315.000 C
1316.000 C COMPLEX CORRELATION ROUTINE
1317.000 C
1318.000 C
1319.000 C SIG SIGNAL
1320.000 C LURD ORDER
1321.000 C R OUTPUT COEFFICIENTS
1322.000 C NTOT NUMBER OF TOTAL DATA POINTS IN SIG
1323.000 C
1324.000 C .....
1325.000 C
1326.000 COMMON/SW/ISW(0:15)
1327.000 COMMON/NEST,NAV,IFST,IWNDW,LORD,ALPHA,WCTS(126),NO
1328.000 COMMON/SIGNL/ SIG(1024),RSLT(1024),WORK(1024),
1329.000 1NPTS, NPTS, NSTR, NTOT, NDAT, PSIG, SNRF, SNR,
1330.000 2ISYNDAT, GSIG, GNOISE, FREQ, SIGMA
1331.000 COMPLEX SIG, R(129), CSUM, WCTS
1332.000 EQUIVALENCE (R(1), RSLT(1))
1333.000 LOGICAL ISW
1334.000 ILURD=LORD
1335.000 C
1336.000 C IF SIG ARRAY IS COMING FROM ALPF USE THE FIRST NDAT PTS OF THE AF
1337.000 C
1338.000 C IF (.NOT.(ISW(12))) GOTO 1093
1339.000 C NDC=1
1340.000 C NDC=NDAT
1341.000 C GOTO 1096
1342.000 CC
1343.000 CC IF SIG ARRAY IS NOT COMING FROM ALPF USE THE LAST NDAT PTS
1344.000 CC
1345.000 1093 NDC=1
1346.000 NDC=NDAT
1347.000 1096 10 100 L=0, ILORD
1348.000 CSUM=CMPLX(0.,0.)
1349.000 NML=NDC-L
1350.000 DO 200 K=NDC,NML
1351.000 200 CSUM=CSUM+CONJG(SIG(K))*SIG(K+L)
1352.000 100 R(L+1)=CSUM/NTOT
1353.000 RETURN
1354.000 END

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1403.000      SUBROUTINE SEKPKP (IST,J)
1404.000 C
1405.000 C
1406.000 C *****
1407.000 C
1408.000 C
1409.000 C      ROUTINE TO CALCULATE FIRST CIRCULAR MOMENT (MEAN
1410.000 C      FREQUENCY) AND HALF POWER WIDTH OVER ENTIRE SPECTRUM
1411.000 C      AND THEN RECALCULATE POWER OVER ONLY SPECTRUM
1412.000 C      BANDWIDTH ABOUT MEAN FREQ.
1413.000 C
1414.000 C
1415.000 C      RSL1      ARRAY WITH SPECTRUM
1416.000 C      IST      NUMBER OF ESTIMATOR
1417.000 C      J      NUMBER OF ESTIMATION
1418.000 C      NPTS     NUMBER OF POINTS IN RSL1
1419.000 C
1420.000 C *****
1421.000 C
1422.000 C
1423.000      COMMON/PKS/PEAKS(3,1024,8)
1424.000      COMMON/SIGL/SIG(1024),RSLT(1024),WORK(1024),
1425.000      1NPTSF,NPTS,NS1PT,NTOT,NDAT,PSIG,SNRF,SNR
1426.000      COMMON/PLS/XNCRM(10),ICT,LOGSCL,FIRST,IPXFL
1427.000      COMPLEX SIG
1428.000 C
1429.000 C      FIND FIRST CIRCULAR MOMENT AND WIDTH
1430.000 C
1431.000      DELW=6.28319/FLOAT(NPTSF)
1432.000      SUMC=0.0
1433.000      SUMS=0.0
1434.000      POWER = 0.0
1435.000      FRQM1=0.0
1436.000      WIDTH = 0.0
1437.000      DO 100 I=1,NPTSF
1438.000      SI=RSLT(I)
1439.000      W=DELW*FLOAT(I-1)
1440.000      SUMC=SUMC+SI*COS(W)
1441.000      SUMS=SUMS+SI*SIN(W)
1442.000      POWER = POWER + SI
1443.000      FRQM1 = FRQM1 + SI*W
1444.000      WIDTH = WIDTH + SI*W*W
1445.000 100 CONTINUE
1446.000      FRQM1=FRQM1/POWER/6.28319
1447.000      FREQDA=ATAN2(SUMS,SUMC)/6.28319
1448.000 C      OUTPUT J,FREQDA
1449.000      NFRQ=FREQDA*NPTSF+0.5
1450.000 C
1451.000 C      (2*PI)**2 = 39.4784
1452.000 C
1453.000      WIDTH=WIDTH/POWER/39.4784 - FRQM1*FRQM1
1454.000      WIDTH=SQRT(WIDTH)

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1455.000 IF(FREQDA.GT.0.5) FREQDA=FFECDA-1.0

1456.000 C

1457.000 C SUM UP POWER OVER SPECTRUM WIDTH

1458.000 C

1459.000 NP=2.*WIDTH*NPTS

1460.000 N1=NFRQ-NP

1461.000 NN1=NPTS+N1

1462.000 IF(N1.LT.1) N1=1

1463.000 N2=NFRQ+NP

1464.000 IF(N2.GT.NPTS) N2=NPTS

1465.000 POWER=0.

1466.000 DO 200 I=N1,N2

1467.000 200 POWER=POWER+RSLT(I)

1468.000 DO 201 I=NN1,NPTS

1469.000 201 POWER=POWER+RSLT(I)

1470.000 POWER=POWER/XNORM(IST)

1471.000 C

1472.000 C PUT THE THREE VARIABLES INTO AN ARRAY, AND

1473.000 C

1474.000 PEAKS(1,J,IST)=POWER

1475.000 PEAKS(2,J,IST)=FREQDA

1476.000 PEAKS(3,J,IST)=WIDTH

1477.000 C OUTPUT J,FREQDA

1478.000 RETURN

1479.000 END

1480.000 C

1481.000 C

1482.000 C

1483.000 SUBROUTINE FLSPEC (IST)

1484.000 C

1485.000 C *****

1486.000 C

1487.000 C

1488.000 C ROUTINE TO PLOT THE SPECTRUM IN RSLT

1489.000 C

1490.000 C RSLT ARRAY CONTAINING SPECTRUM

1491.000 C NPTS NUMBER OF POINTS IN RSLT

1492.000 C IST NUMBER OF ESTIMATOR

1493.000 C IREC NUMBER OF RECORD

1494.000 C LOGSCL FLAG FOR LINEAR OR LOG PLOT

1495.000 C XNORM ARRAY CONTAINING NORMALIZATIONS

1496.000 C

1497.000 C *****

1498.000 C

1499.000 COMMON/SIGNL/SIG(1024),RSLT(1024),WORK(1024),

1500.000 1NPTS,NPTS,NSIRT,NTUT,NDAT,PSIG,SNRF,SNF,

1501.000 2ISYNDAT,GSIG,GNOISE,FREQ,SIGMA

1502.000 COMMON/PLS/ XNORM(10),ICT,LOGSCL,FIRST,IPXFL,LNAME(4),LPL

1503.000 COMMON/NEST,NAV,TEST,IWNDW,LORD,ALPHA,WGTS(128),NO

1504.000 COMMON/SH/ISW(0:15)

1505.000 COMPLEX SIG,WGTS

1506.000 LOGICAL FIRST,IPL,PLCH,ISW

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1507.000 DIMENSION IDT(3),ITM(3)
1508.000 ISTD=IST
1509.000 1 IF (ISW(12)) GOTO 95
1510.000 GOTO 97
1511.000 95 IF (IST.FQ.6) ISTD=8
1512.000 97 IF (LOGSCL) 100,100,200
1513.000 C
1514.000 C LINEAR SCALE
1515.000 C
1516.000 100 YMIN=0.
1517.000 YMAX=XNORM(ISTD)
1518.000 YTIC=YMAX/10.
1519.000 GO TO 300
1520.000 C
1521.000 C LOG SCALE
1522.000 C
1523.000 200 XNRM=XNORM(ISTD)
1524.000 YMIN=-80.
1525.000 YMAX=3.
1526.000 C YMAX=3.
1527.000 YTIC=10.
1528.000 C
1529.000 C SET UP WINDOW
1530.000 C
1531.000 300 CALL TWINDO (50,1000,25,700)
1532.000 C NPTS2=2*NPTS
1533.000 XMAX=FLOAT(NPTS/2)
1534.000 XMIN=1.-XMAX
1535.000 CALL DWINDO (XMIN,XMAX,YMIN,YMAX)
1536.000 C
1537.000 C IF SWITCH 13 IS UP, DO AN AXIS AND RESET IPXFL
1538.000 C
1539.000 300 CONTINUE
1540.000 IF ((.NOT.FIRST)) GO TO 400
1541.000 AX1=1.
1542.000 AX2=YMIN
1543.000 AX3=FLOAT(NPTS)/10.
1544.000 AX4=YTIC
1545.000 CALL AXIS(AX1,AX2,AX3,AX4)
1546.000 IPXFL=0
1547.000 C
1548.000 C DETERMINE OUTPUT OF DASHED LINE
1549.000 C
1550.000 400 L=ISTD-1
1551.000 IF (ISTD.FQ.8) L=3
1552.000 IF (ISTD.FQ.6) L=4
1553.000 IF (ISTD.FQ.5) L=0
1554.000 C
1555.000 C PLOT SPECTRUM
1556.000 C
1557.000 NPTS2=NPTS/2
1558.000 Y=KSLT(NPTS2+1)

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1559.000      IF(Y.F2.0)OUTPUT Y,XNRM
1560.000      IF(LEGSCL.G1.0) Y=10.*ALOG10(Y/XNRM)
1561.000      CALL MOVEA (XPIN,Y)
1562.000      IPIK=2-NPTS2
1563.000      DO 500 I=IPIK,0
1564.000      X=1
1565.000      Y=PSLT(NPTS2+1)
1566.000      IF(LEGSCL.G1.0) Y=10.*ALOG10(Y/XNRM)
1567.000      CALL DASHA (X,Y,L)
1568.000 500   CONTINUE
1569.000      DO 501 I=1,NPTS2
1570.000      X=1
1571.000      Y=PSLT(I)
1572.000      IF(LEGSCL.G1.0) Y=10.*ALOG10(Y/XNRM)
1573.000      CALL DASHA (X,Y,L)
1574.000 501   CONTINUE
1575.000 600   CALL ANMODE
1576.000 C      NPTS2=NPTS2/2
1577.000      RETURN
1578.000      END
1579.000 C
1580.000 C
1581.000 C
1582.000      SUBROUTINE SPCAV (ISTT,ILP10)
1583.000 C
1584.000 C      BLOCK AVERAGE FIRST NAV ESTIMATES
1585.000 C      EXPONENTIAL AVERAGE AFTER FIRST NAV
1586.000 C      PUT IN RSLT FOR PLOTTING
1587.000 C
1588.000      COMMON/SIGNL/ SIG(1024),RSLT(1024),WORK(1024),
1589.000 1NPTS2,NPTS,ASRT,NTOT,NDAT,PSIG,SNRF,SNR,
1590.000 2ISYNDAT,GSIG,GNOISE,FREQ,SIGMC
1591.000      COMMON NEST,NAV,IEST,IWNDK,LORD,ALPHA,WCTS(126),NO
1592.000      COMPLEX SIG,WGTS
1593.000      FNAV=FLOAT(NAV)
1594.000      IF(ILP10.LE.NAV) FNAV=FLOAT(ILP10)
1595.000      XD=1./FNAV
1596.000      XA=1.-XD
1597.000      DO 30 I=1,NPTS2
1598.000      WORK(I)=XA*WORK(I) + XD*RSLT(I)
1599.000 30      RSLT(I) =WORK(I)
1600.000      RETURN
1601.000      END
1602.000 C
1603.000 C
1604.000 C
1605.000      SUBROUTINE ESKRD (IST,IHIST)
1606.000 C
1607.000 C
1608.000 C *****
1609.000 C
1610.000 C

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1611.000 C
1612.000 C ROUTINE TO READ PEAKS, POWERS, AND VARIANCES FROM PEAKS
1613.000 C
1614.000 C
1615.000 C *****
1616.000 C
1617.000 C
1618.000 COMMON NEST, NAV, IEST, IWNDW, LORD, ALPHA, WCTS(128), NO
1619.000 COMMON/PEAKS/PEAKS(3,1024,R)
1620.000 COMMON/SIGNAL/ SIG(1024), RSLT(1024), WORK(1024),
1621.000 1NPTSF, NPTS, NSTRT, NTOT, NDAT, PSIG, SNRF, SNR,
1622.000 2ISYNLAT, GSIG, GNOISE, FREQ, SIGMA
1623.000 COMPLEX SIG, WCTS
1624.000 C
1625.000 C STORE REQUESTED INFO IN WORK
1626.000 C
1627.000 DO 100 I=1, NEST
1628.000 WORK(I)=PEAKS(IHIST,I,IST)
1629.000 100 CONTINUE
1630.000 RETURN
1631.000 END
1632.000 C
1633.000 C
1634.000 C
1635.000 SUBROUTINE STATS ( XMEAN, STDEV, NRINS)
1636.000 C
1637.000 C ROUTINE TO DO STATISTICAL ANALYSES ON WORK (NEST)
1638.000 C
1639.000 C OUTPUTS FROM STATS
1640.000 C XMEAN--> MEAN OF W
1641.000 C STDEV--> STANDARD DEVIATION OF W
1642.000 C
1643.000 COMMON/SIGNAL/ SIG(1024), RSLT(1024), WORK(1024),
1644.000 1NPTSF, NPTS, NSTRT, NTOT, NDAT, PSIG, SNRF, SNR,
1645.000 2ISYNLAT, GSIG, GNOISE, FREQ, SIGMA
1646.000 COMMON NEST, NAV, IEST, IWNDW, LORD, ALPHA, WCTS(128), NO
1647.000 COMPLEX SIG, WCTS
1648.000 SUM=0
1649.000 SUMSD=0
1650.000 DW=6.28319/FLOAT(NRINS)
1651.000 SUMC=0,
1652.000 SUMS=0,
1653.000 DO 10 I=1, NRINS
1654.000 W=RSLT(I)
1655.000 XW=DW*FLOAT(I-1)
1656.000 SUMC=SUMC+W*COS(XW)
1657.000 SUMS=SUMS+W*SIN(XW)
1658.000 10 CONTINUE
1659.000 XMEAN=ATAN2(SUMS, SUMC)
1659.040 C OUTPUT XMEAN
1659.100 IF(XMEAN.GT.0) GOTO 91
1659.400 XMEAN=-1*XMEAN

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1660.000 XMEAN=6.26319-XMEAN
1661.000 C OUTPUT XMEAN
1662.000 91 DO 97 I=1,NBINS
1663.000 XW=DW*FLCAT(I-1)
1664.000 XMD=XMEAN-XW
1665.000 IF(XMD.LT.0)INDEX=I-1
1666.000 IF(XMD.LT.0)GOTO 98
1667.000 97 CONTINUE
1668.000 C OUTPUT INDEX,DW
1669.000 98 INDEX=INDEX-NBINS/2-1
1670.000 XMEAN=(INDEX-.5)/FLOAT(NBINS)
1671.000 C OUTPUT XMEAN,INDEX
1672.000 DO 19 I=1,NEST
1673.000 ATEST=WORK(I)-XMEAN
1674.000 ATEST1=ATEST**2
1675.000 TEST=SQRT(ATEST)
1676.000 TEST1=1.-TEST
1677.000 IF(TEST.GT..5)ATEST=TEST1**2
1678.000 19 SUMSD=ATEST+SUMSD
1679.000 STDEV=SQRT(SUMSD/(NEST-1))
1680.000 RETURN
1681.000 END
1682.000 C
1683.000 C
1684.000 C
1685.000 C
1686.000 SUBROUTINE HIST (HMAX,NBINS, IHIST)
1687.000 C
1688.000 C ROUTINE TO DO HISTOGRAM ON WORK(NEST)
1689.000 C WORK--> INPUT ARRAY WITH RAW DATA
1690.000 C RSLT--> OUTPUT ARRAY WITH HISTOGRAM
1691.000 C HMAX--> LARGEST VALUE IN HIST
1692.000 C
1693.000 COMMON/SIGNL/ SIG(1024),RSLT(1024),WORK(1024),
1694.000 1NPTS,1PTS,1STRT,1TUT,1DAT,1SIG,1SNR,1SNR,
1695.000 2ISYNDAT,GSIG,1NOISE,FREQ,SIGMG
1696.000 COMMON NEST,NAV,1EST,1WINDW,LORD,ALPHA,WCTS(126),NO
1697.000 COMPLEX SIG,WCTS
1698.000 HMAX=1.
1699.000 DO 10 I=1,NBINS
1700.000 10 RSLT(I)=0.
1701.000 DO 100 I=1,NEST
1702.000 IF (IHIST-2) 200,300,400
1703.000 C
1704.000 C POWER NORMALIZED TO (0,2.0)
1705.000 200 INDEX=0.5*FLCAT(NBINS)*WORK(I)+0.5
1706.000 GO TO 500
1707.000 C
1708.000 C FREQUENCY NORMALIZED TO (0-.5,+0.5)
1709.000 C
1710.000 300 INDEX=FLOAT(NBINS)*WORK(I)+0.5
1711.000 INDEX=INDEX + NBINS/2 + 1
1712.000 GO TO 500

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1713.000 C
1714.000 C      WIDTH NORMALIZED TO (0.0,0.5)
1715.000 C
1716.000 400    INDEX=2.*FLCAT(NBINS)*WORK(1)+0.5
1717.000 500    IF (INDEX.LT.1) INDEX=1
1718.000        IF (INDEX.GT.NBINS) INDEX=NBINS
1719.000        RSLT(INDEX)=RSLT(INDEX) + 1
1720.000        IF (RSLT(INDEX).GT.HMAX) HMAX=RSLT(INDEX)
1721.000        IF (RSLT(INDEX).EQ.HMAX) HIND=INDEX
1722.000 100    CONTINUE
1723.000 C      OUTPUT HMAX,HIND
1724.000        RETURN
1725.000        END
1726.000 C
1727.000 C
1728.000 C
1729.000        SUBROUTINE HPLT (HMAX,XMEAN,STDEV,NBINS,IHIST,IST)
1730.000 C
1731.000 C *****
1732.000 C
1733.000 C
1734.000 C      ROUTINE TO PLOT HISTOGRAMS FROM RSLT
1735.000 C
1736.000 C
1737.000 C *****
1738.000 C
1739.000 C
1740.000        COMMON NEST,XAV,IEST,IWNDW,LORD,ALPHA,WGTS(126),NO
1741.000        COMMON/SIGNL/ SIG(1024),RSLT(1024),WORK(1024),
1742.000        1NFTSF,NPIS,NSTHT,NTOT,NDAT,PSIG,SNRF,SNF,
1743.000        2ISYNDAT,GSIG,CNOISE,FREQ,SIGMA
1744.000        COMMON/PLS/ XNORM(10),ICT,LOGSCL,FIRST,IPXFL
1745.000        COMMON/LBLS/LABEL(10,B)
1746.000        COMPLEX SIG,WGTS
1747.000        DIMENSION IDI(3),ITM(3)
1748.000        IPC=(HMAX/FLCAT(NEST))*100.+1.
1749.000        PC=FLOAT(IPC)*FLOAT(NEST)/100.
1750.000        CALL DWINDO (1.,FLOAT(NBINS),0.,PC)
1751.000        CALL TWINDO (100,1000,100,750)
1752.000        PC10=PC/10.
1753.000        PTS10=FLOAT(NBINS)/10.
1754.000        XAX=1.
1755.000        IF (IHIST.EQ.2) XAX=NBINS/2+1
1756.000        CALL AXIS (XAX,0.,PTS10,PC10)
1757.000        CALL RECOVR
1758.000        CALL MOVEA (1.,0.)
1759.000        DO 10 I=1,NBINS
1760.000        CALL DRAWA (FLOAT(I),RSLT(I))
1761.000        CALL DRAWA (FLOAT(I+1),RSLT(I))
1762.000 10      CONTINUE
1763.000        CALL HOME
1764.000        CALL ANMODE
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1765.000 X      ACCEPT '<7>',IDUM
1766.000 110    WRITE (10,1090) LORD,NBINS
1767.000 1090   FORMAT (' (ORDER=',13,' BINS=',14,')')
1768.000 C      GO TO 200
1769.000 C130   WRITE (10,1030) LORD,ALPHA,NPINS
1770.000 1030   FORMAT (' (ORDER=',13,' ALP=',F4.2,' BINS=',14,')')
1771.000 200    WRITE (10,2000) NEST,NTOT,SNR,XMEAN,STDEV
1772.000 2000   FORMAT (' ',14,' ESTIMATES ',14,' SAMPLES/ESTIMATE ',F5.1,
1773.000 1       ' DB SNR',/,/, ' MEAN:',F8.5,' ST. DEV.:',F7.5,2)
1774.000        OUTPUT ' '
1775.000        OUTPUT ' '
1776.000        IF(IST.EQ.1)OUTPUT 'FFT HISTOGRAM'
1777.000        IF(IST.EQ.5)OUTPUT 'WGTS HISTOGRAM'
1778.000        IF(IST.EQ.6)OUTPUT 'ALPF HISTOGRAM'
1779.000        IF(IST.EQ.8)OUTPUT 'MULTILAG HISTOGRAM'
1780.000        OUTPUT ' '
1781.000        OUTPUT ' '
1782.000        OUTPUT'HARD COPY 1=YES,0=NO'
1783.000        INPUT HDAN
1784.000        IF(HDAN.EQ.1)CALL HDCOPY
1785.000        CALL XAPAG
1786.000        RETURN
1787.000        END
1788.000 C
1789.000 C
1790.000 C
1791.000        SUBROUTINE FFT (M,INV)
1792.000
1793.000 C
1794.000 C      DESCRIPTION OF PARAMETERS:
1795.000 C      SIG-AS INPUT CONTAINS COMPLEX ONE-DIMENSIONAL
1796.000 C      ARRAY TO BE TRANSFORMED
1797.000 C      -AS OUTPUT-CONTAINS THE COMPLEX FOURIER TRANSFORM
1798.000 C      M-DEFINES THE DIMENSION OF A.
1799.000 C      THE SIZE OF N(OF A) = 2**M
1800.000 C      N-DIMENSION OF A
1801.000 C      INV-OPTION PARAMETER
1802.000 C          1. 0 TAKES TRANSFORM OF A
1803.000 C          -1. 0 TAKES INVERSE TRANSFORM OF A
1804.000 C      NOTE: N MUST BE A POWER OF 2
1805.000 C
1806.000        COMMON/SIGNL/ SIG(1024),RSLT(1024),WORK(1024),
1807.000        1NPTSF,NPTS,ASTRT,NTOT,NDAT,PSIG,SNRF,SNF,
1808.000        2ISYNDAT,GSIG,GNOISE,FREQ,SIGMA
1809.000        COMPLEX SIG,U,W,T,C
1810.000        N=2**M
1811.000 C          DO 2 IID=1,N
1812.000 C2         OUTPUT SIG(IID)
1813.000        NV2=N/2
1814.000        NM1=N-1
1815.000        J=1
1816.000 C          OUTPUT N,NV2,J,INV

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1817.000 C
1818.000 C THIS LOOP PERFORMS THE BIT-REVERSAL
1819.000 C OPERATION ON THE INDEX OF A
1820.000 C
1821.000 DC 7 J=1,NM1
1822.000 IF (I .GE. J) GO TO 5
1823.000 T=SIG(J)
1824.000 SIG(J)=SIG(I)
1825.000 SIG(I)=T
1826.000 5 K=NV2
1827.000 6 IF (K .GE. J) GO TO 7
1828.000 J=J-K
1829.000 K=K/2
1830.000 GO TO 6
1831.000 7 J=J+K
1832.000 PI=3.14159265359
1833.000 TNV=- TNV
1834.000 DC 20 L=1,M
1835.000 LE=2 **L
1836.000 LE1=LE/2
1837.000 U=(1.,0.)
1838.000 W=CMPLX(COS(PI/LE1),TNV*SIN(PI/LE1))
1839.000 DO 20 J=1,LE1
1840.000 DO 10 I=J,N,LE
1841.000 IP=1+LE-1
1842.000 T=SIG(IP)*U
1843.000 SIG(IP)=SIG(J)-T
1844.000 10 SIG(I)=SIG(I)+T
1845.000 20 U=U*W
1846.000 TNV=-TNV
1847.000 C OUTPUT A,NV2,J,TNV
1848.000 C DO 21 IDID=1,N
1849.000 C21 OUTPUT SIG(IDID)
1850.000 IF (TNV .GT. 0) RETURN
1851.000 C
1852.000 C IF TNV=-1 WE HAVE THE INVERSE TRANSFORM
1853.000 C
1854.000 S=1./N
1855.000 C=CMPLX(S,0.)
1856.000 DC 30 I=1,N
1857.000 SIG(I)=C*SIG(I)
1858.000 C OUTPUT SIG(I)
1859.000 30 CONTINUE
1860.000 RETURN
1861.000 END
1862.000 C
1863.000 C
1864.000 C
1865.000 SUBROUTINE AXIS(X,Y,XTIC,YTIC)
1866.000 CALL SPEEDW(XMIN,XMAX,YMIN,YMAX)
1867.000 CALL MOVEA(XMIN,Y)
1868.000 CALL DRAWA(XMAX,Y)

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1669.000 CALL MOVEA(X,YMIN)
1670.000 CALL DRAWA(X,YMAX)
1671.000 IF (XTIC .LE. 0) GO TO 10
1672.000 NX=(XMAX-XMIN)/XTIC+1
1673.000 MAX=(X-XMIN)/XTIC
1674.000 XO=X-XTIC*MAX
1675.000 DO 20 I=1,NX
1676.000 CALL MOVEA(XO,Y)
1677.000 CALL MOVREL(0,10)
1678.000 CALL DRAWREL(0,-20)
1679.000 XO=XO+XTIC
1680.000 20 CONTINUE
1681.000 10 IF (YTIC .LE. 0) GO TO 30
1682.000 NY = (YMAX-YMIN)/YTIC+1
1683.000 MAY=(Y-YMIN)/YTIC
1684.000 YO=Y-YTIC*MAY
1685.000 DO 40 I=1,NY
1686.000 CALL MOVEA(X,YO)
1687.000 CALL MOVREL(10,0)
1688.000 CALL DRAWREL(-20,0)
1689.000 YO=YO+YTIC
1690.000 40 CONTINUE
1691.000 30 CALL HOME
1692.000 RETURN
1693.000 END
1694.000 FUNCTION IBITR(J,NU)
1695.000 J1=J
1696.000 IBITR=0
1697.000 DO 200 I=1,NU
1698.000 J2=J1/2
1699.000 IBITR=IBITR*2+(J1-2*J2)
1700.000 200 J1=J2
1701.000 RETURN
1702.000 END
1703.000 C
1704.000 C
1705.000 C
1706.000 FUNCTION IRAN(DUM)
1707.000 C
1708.000 C RANDOM + - # BETWEEN 0 + 1
1709.000 C
1710.000 DIMENSION RAN(1)
1711.000 NSEED=1
1712.000 CALL RNDU(RAN,NSEED)
1713.000 ASS=100*RAN(1)
1714.000 CALL RNDU(RAN,NSEED)
1715.000 DS=-1** (ASS*RAN(1))
1716.000 CALL RNDU(RAN,NSEED)
1717.000 DRAN=DS*RAN(1)
1718.000 RETURN
1719.000 END

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